EIGHTH BIENNIAL REPORT

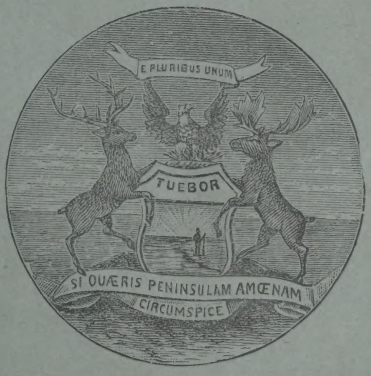
OF THE

STATE BOARD

OF

FISH COMMISSIONERS

FROM DEC. 1, 1886, TO DEC. 1, 1888.



BY AUTHORITY.

LANSING:
DARIUS D. THORP, STATE PRINTER AND BINDER.
1888.

EIGHTH BIENNIAL REPORT

OF THE

STATE BOARD

OF

FISH COMMISSIONERS

FROM DEC. 1, 1886, TO DEC. 1, 1888.

BY AUTHORITY.

LANSING:
DARIUS D. THORP, STATE PRINTER AND BINDER.
1888.

STATE BOARD OF FISH COMMISSIONERS.

1888.

COMMISSIONERS.

JOHN H. BISSELL, President, - - - BANK CHAMBERS, DETROIT.
HERSCHEL WHITAKER, - - - - - MOFFAT BLOCK, DETROIT.
DR. JOEL C. PARKER, - - - - - GRAND RAPIDS.

SUPERINTENDENT.

WALTER D. MARKS, - - - - - PARIS, MECOSTA COUNTY.

SECRETARY.

GEORGE D. MUSSEY, - - - - NO. 33 MOFFAT BLOCK, DETROIT.

TREASURER.

WM. A. BUTLER, JR., - - - - MECHANICS' BANK, DETROIT.

OFFICE OF THE BOARD.

NO. 33 MOFFAT BLOCK, DETROIT, MICH.

TABLE OF CONTENTS.

I.

II.

III.

IV.

V.

VI.

APPENDIX.

STATE BOARD OF FISH COMMISSIONERS.

EIGHTH BIENNIAL REPORT.

To the Hon. Cyrus G. Luce, *Governor of the State of Michigan:*

Agreeably to the duty imposed upon the State Board of Fish Commissioners by law, they herewith respectfully submit their Eighth Biennial Report.

The Seventh Biennial Report brought the account of the affairs and operations of this board, down to December 1, 1886. This report, beginning at that date, covers all transactions down to the 1st of December, 1888.

I.—THE GENERAL WORK OF THE COMMISSION.

A.—LEGISLATION.

During the session of the Legislature in 1887 the commissioners were often at Lansing, attending meetings of the Fisheries Committees of the Senate and House of Representatives; and spent as much time as seemed to be required, in explaining to the members of both Houses the work and needs of this department; and, also, in presenting the legislation deemed necessary for the preservation of the fisheries of the state. The board prepared and submitted several bills, which it believed, from its experience, were required to be engrafted upon our statutes for the better protection of fish. The proposed legislation presented an entire scheme for revision of the fishery statutes and the enactment in their place of three statutes providing: (a), for the regulation of the fishing in inland lakes and streams, including all merely sporting fishing; (b), for regulation of the industrial fisheries, and (c), for the enforcement of the fishery laws. The Fishery Committee of the House reported the three bills favorably. Only one of them, however, was passed, that regulating the inland fisheries. The second was passed by the House, but failed of receiving consideration in the last hours of the Senate's session, the third was anticipated by the passage of the Act under which the present State Game and Fish Warden was appointed.

The law passed for the regulation of inland fisheries, being Act No. 265, Session Laws 1887, p. 350, requires amendment by adding a few words in the third line of section 9, which were in the bill as reported to and passed by the House, but by some oversight were omitted in the engrossed copy signed by the Governor. The journal shows no amendment in the Senate. That section, as it stands in the present law, reads as follows:

SEC. 9. "It shall not be lawful hereafter to kill or capture the black, strawberry, green, or white bass, except with hook and line, in any lake, river or stream in or bordering this State between the first day of March in each year and the fifteenth day of June thereafter, etc."

This section should be amended to read as follows:

SEC. 9. "It shall not be lawful hereafter to kill or capture the black, strawberry, green or white bass, except with hook and line, in any lake, river or stream in or bordering this State; *nor to kill or capture such fish in any manner* between the first day of March and the fifteenth day of June thereafter in each year; nor during, etc."

The words to be inserted are printed in italics. The journal of the last Legislature shows that no such amendment, as would warrant the omission of the words, was made, and in fact the entire wording of the section in the succeeding lines shows that the change actually made was not contemplated. The last eleven words of the section should be omitted as unnecessary. The point of the whole matter is this, that the black bass and muskallonge have become so scarce that it is necessary to protect them by what is generally known as a "close season." That is, a period covering, and just prior to, their spawning season is provided, during which they are not to be killed, or captured, in any manner; nor during the same time to be had in one's possession. They ought not at any time to be captured in any other manner than with hook and line. Both of these varieties are among our most valuable native fish for sporting purposes, both are becoming scarce, and unless they are protected, as this law contemplates they shall be, they will be substantially exterminated. The close season from March 1 to June 15, when these fish are not to be taken at all, and the prohibition of their capture at other times by nets, spears or any other appliance, except hook and line, will go far towards giving them opportunity to reproduce in sufficient quantities to maintain themselves in the waters where they are now found, and also give them an opportunity to become established in waters where they may be planted hereafter by the commission.

There is one other point which we now urge upon the Legislature to provide for the protection of black bass; it is to make it unlawful for any one to kill a bass of less than ten (10) inches in length. A similar provision for muskallonge of less than three (3) pounds in weight would furnish protection to a valuable fish.

A brief inspection of fish markets would show large numbers of bass that were not old enough to have passed their first spawning season. This should be stopped.

The Fisheries Committee of the House in 1887 devoted a large amount of valuable time to consideration of the measures presented and recommended by this board. They took great pains to inform themselves about the condition and needs of the fisheries, and listened with respectful attention to every statement and argument addressed to them bearing upon the important interests committed to them. We take the liberty of making mention of their action, as it resulted in their recommending the laws presented by this board, and in an intelligent approval of its work and action generally. The work of this commission has never failed of receiving liberal support and approval at the hands of the Legislature when it has been intelligently investigated and understood. We ought to add also that the bills presented by the commissioners were very much improved by suggestions and criticism at the hands of the committee.

B.—ORGANIZATION AND DIVISION OF THE BOARD'S WORK.

It was found convenient to systematize the work of this board by parcelling among the commissioners the different stations and kinds of operations. Acccordingly, at the meeting held in December, 1886, the following distribution was made: Dr. Parker took the stations at Glenwood and Petoskey; the Paris Station and trout breeding were assigned to Mr. Bissell; the Detroit Station and grayling experiments, to Mr. Whitaker. This division of work, originally made for one year, has been continued during 1888, and consequently covers the same period as the report. Monthly reports in writing are made by the overseers of the several stations to the Superintendent, which are forwarded by him to the commissioner in charge of the same; and these reports are included in the reports made by the commissioners at each monthly meeting. The reports are then filed in the Secretary's office and become part of the board's permanent records During the past two years the board has held its regular meetings monthly, and such special meetings as were required. The regular meetings are on the fourth Tuesday of each month, and are usually held at the office in Detroit. The residence of two commissioners in Detroit, which is necessarily the headquarters of the board's operations, has been found during the past six years a great convenience, as occasion frequently arises for consultation by a majority of the commissioners upon subjects that must be promptly considered and decided.

In March, 1888, Mr. A. J. Kellogg, who had been Secretary of the Commission since 1885, resigned that office, and the present incumbent, Mr. George D. Mussey, of Detroit, was appointed to fill the vacancy. Mr. Kellogg's long experience on the board as a commissioner and intimate acquaintance with the history of its operations was of service in systematizing the work of the office. The board was fortunate in securing the services of a competent and thoroughly trained man to supply his place, so that the business of the office has proceeded with little inconvenience from the change.

Mr. Walter D. Marks has continued as Superintendent of Fisheries during the two years, giving excellent service to the board, and at all times securing prompt and efficient service from the force under his direction. The board gladly make this public acknowledgment of their thorough appreciation of his intelligent, manly and skillful performance of all official duties to the state. The Superintendent has been fortunate in having the assistance of competent and thorough workers on the force, who deserve commendation for their skill and readiness to do all that their places require of them.

Mr. William A. Butler, Jr. has continued as Treasurer of the board, and has been of great service, not only in keeping the funds appropriated by the State safely and in a most business-like way; but also in furthering the interests of the commission at home, and among the fish culturists of the country, in ways not required by the duties of his office. As his important services have been voluntary they are all the more appreciated by the commissioners who have been greatly aided by them.

As at present organized the board is better equipped and working to better advantage than ever before in its efforts to develop and promote the fishery interests of the state.

C.—ENCOURAGEMENT IN FISH CULTURE.

1. There is good ground for encouragement in the various branches of this work. Each year the subject of fish culture, or "water culture," is being better understood by the people of the state. Year by year improvements are made in the methods of fish rearing and transportation, so that practical results are now being obtained, that a few years ago were not anticipated. The results are beginning to be generally appreciated; and the fishery officers are constantly seeing new opportunities for applying more effectively their methods and experiences to the increase of the fish supply. If one will take the pains to compare the product of the State hatcheries four and five years ago with what it has been for the past two years, and then consider that the results already attained are wholly from the smaller numbers of fish then hatched and planted, he will be better able to realize the grounds of our faith in far more inportant and permanent results. For instance, all the plants of brook-trout from which results have been yet observed are of the year 1885, and principally of the years prior to that. But the product of that year, 1885, was only 408,000 fry of brook-trout; the number planted in the following seasons of '86, '87 and '88, was over thirty four hundred thousand (3,400,000); the number in 1886 was 719,000, that of 1887, 1,085,000; that of 1888, 1,639,000.

There is every reason to expect that relatively the same ratio of increase can be maintained for the seasons of 1889 and 1890; if so, the product for for the former year should be about 2,300,000, and for the latter, about 2,800,000. After that time the Paris Station may be counted on, unless interfered with by some unforeseen accident, for an annual product of three millions and upwards. If the planting of four hundred thousand brook-trout or less each year (up to 1885) has produced unexpected and most satisfactory results in seventy or eighty streams, what may we not reasonably expect from the deposit of three millions in one hundred and seventy streams and rivers each year? The extension of railway lines has opened up more territory in which our operations can be extended, and it is hardly too much to say that nearly ever stream in the lower peninsula of the State, north of Montcalm, Gratiot, and Saginaw counties, is suitable for brook-trout. It is also probably within bounds to say that in this vast region, not one-half of the streams suitable for brook-trout have yet been planted.

It must not be understood that no streams south of the region thus indicated can be successfully stocked with trout, for up to the present time more streams south of the line mentioned have been planted with trout than north of it. It is, however, undoubtedly true that the proportion of suitable streams south of that line is much smaller than of those to the northward of it. During the period covered by the 6th and 7th biennial reports, that is from 1883 to 1886, both inclusive, brook-trout were distributed in more counties south of that line than north of it. And in some of those more southern counties have occurred many instances of remarkable growth of fish.

But why raise three millions of trout a year? Why aim at that figure, or, for that matter, at any other? Is it not enough to plant a stream once? That involves a discussion longer than most of our readers would have the patience to follow; so we must be content to state the problem and our answer to it as briefly as possible, leaving for oral answer anything more exhaustive on this subject. In the first place, nine-tenths, or over, of the streams in the

lower peninsula of the state which this board has stocked, or is now stocking with brook-trout, never were trout streams before they were made such by the State. They are therefore not streams in which the natural stock of trout has been exhausted by over fishing. So that, without knowing the exact conditions under which the trout exists in those streams, no one can surely say the supply will be unfailing, nor predict with certainty that in a given number of years the fish will not all be caught out. The most that any one can say is, the natural supply in other streams that we have known has become exhausted by unlawful, or excessive fishing, and the same causes will undoubtedly produce the like results on these waters under consideration. But here again the statement must be qualified, because in many of these streams there are reaches of water most admirably adapted to the protection of trout; as where they run a part of their course through alder, tamarack, or cedar swamps and thickets; places very difficult to fish in, and furnishing the largest amount of cover for adult fish, as well as cover for the young to grow in. Another condition is the state of public opinion on the subject of protecting the fish as prescribed by law. If the present laws remain in force, and are in the main respected and compiled with, there is little risk in saying that the supply of fish will be maintained for many years. Again, the rapidity with which the country increases its population has an important bearing on the subject. The ratio of growth of population, such as this State has experienced during the last twenty-five years, will each year make larger draughts upon the stock of fish, both as a means of sport and for the supply of food. In those portions of the state where trout-fishing is good, the trade in all branches will be stimulated, and the communities benefited by the amount of money that will be spent each year during the fishing season by visitors from other parts of the state, and from outside the state, who are attracted there by the fishing.

So that, taking the view that the majority of the streams will require re-stocking as often as once in seven or ten years, it will be perfectly apparent to any one making a deliberate and impartial examination of the subject, that for the very moderate expenditure required to maintain the Paris Station—less than five thousand dollars a year—the culture of the streams in the lower peninsula can be carried on in a way that will yield a valuable quantity of food for many citizens, and directly induce the expenditure of several hundred thousands of dollars each year which, but for the fishing, would never be put into circulation in those neighborhoods. It must not be forgotten that this culture of the trout streams is the cultivation of a public domain, and thus the appropriate work of the state; just as in the case of the great lakes. No private individual, and no smaller community, as a town, or county, can do this work. It must be done by the state. Provision being made for the whole state, the work is simplified, systemized, in the hands of skilled men, and on so large a scale that it is prosecuted with remarkable economy; and the same is true of the economy of the plant necessary to be maintained for rearing the fish. This will be thoroughly appreciated by any person who has visited the state trout farm at Paris during the past two years. We give in the appendix to this report some testimony from citizens of the state as to the success attained in the planting of streams with trout, but this is only a small part of the testimony that is constantly coming to the commissioners orally. The growth of public opinion on this subject is worthy of consideration, as it

indicates the sober judgment of the people of the state, for whom the work is done, regarding it. If the planting of brook-trout in so many localities had been a failure, we certainly should have heard of it. But the fact is that in almost every county of the state, if inquiry is made, the same answer will be returned, that it is a pronounced and appreciated success.

The planting of brook-trout has been the most popular work carried on by this board. It has been so successful in palpable results, results so easy of demonstration, in which so many people are interested, in so many widely separated localities, and the benefits to individuals and the community are so direct, that a permanent and decided impression has been made upon the public opinion throughout the state favorable to the continued culture of these fish. This public opinion is justified by the actual condition of very many trout streams which have been made so wholly by our artificial methods; and it will be much increased and intensified when the work of 1887 and 1888 begins to be realized.

2. Special attention is asked to the following report of the Secretary, which gives a complete and definite showing of the exact opinion of those engaged in the fishing business around the shores of the lower peninsula of the state (and also the same for the southern shore of Lake Erie) regarding the work of artificial propagation of whitefish. To fully comprehend the force of this report it should be remembered that five years ago the possibility of doing anything for the fisheries of the great lakes by artificial methods was not admitted by one in five of the men who are now convinced by what they have witnessed for themselves. The board had not the means at its disposal to undertake a complete statistical report, like that in 1885, and directed their investigation solely to the condition of public opinion amongst the fishermen and fish dealers. The following is the

SECRETARY'S REPORT.

To the State Board of Fish Commissioners:

GENTLEMEN,—In accordance with your instructions, I started on the 18th day of September, 1888, on a trip to investigate the condition of fisheries and fishing, particularly with regard to whitefish, on the shores of Lakes Huron and Michigan, and beg leave to report as follows:

At Bay City I saw a number of parties largely interested both as dealers and catchers, one of whom said whitefishing at Tawas, Alabaster, Au Sable and Gravelly Point was better now than at any time during the last ten years. The fish caught at these points were uniformly of good size, very few small fish having been taken. He thought the increase was due to artificial propagation. Another of them thought the planting of whitefish was the only thing that saved the industry from total destruction, and that with proper laws for their protection the supply of whitefish could be completely restored, while another said he was not at all sanguine that artificial propagation was a success. He was of the opinion, however, that with proper laws for protection, rigidly enforced, some good might come from the planting of whitefish fry. He was strongly in favor of a law prohibiting the catching and marketing of whitefish weighing less than one and one-fourth pounds.

At Alpena all the parties interviewed said the catch of whitefish had been steadily decreasing for a number of years. The decrease was, in their

opinion, due wholly to the depositing of saw-dust and refuse from the mills in the waters of the lake. They all believe in artificial propagation and that the present supply of whitefish is the result, largely, of the planting of whitefish fry, but that no increase may be expected until the depositing of saw-dust and refuse is stopped, and unless it is discontinued whitefish will run out entirely.

At Cheboygan very little whitefishing is being done. Those with whom I talked stated that from their knowledge of different points above and below Cheboygan, the amount of whitefish being caught this season was largely in excess of that of any previous season for a number of years, and that much of the increase was due to the work of the commission and the partial enforcement of the present laws for protection. They believe the law is faulty and in many instances works great hardships to the smaller fishermen, many of whom have their all invested in one or two nets, which, to comply with the law, must be abandoned for larger mesh nets. The relinquishment of their present nets is a loss they could not bear because they have no means of procuring others.

At Mackinac Island, Mackinaw City and St. Ignace a number of fishermen and dealers were seen. The universal testimony is that there is an improvement there in the whitefish catch; that the increased supply is due to artificial propagation, and that with proper protection the planting of whitefish fry would be a perfect success and the number of whitefish be largely increased. All favor a law prohibiting the catching and marketing of whitefish weighing less than one and one-fourth pounds, and believe such a law would control the destruction of small whitefish to a greater extent, with less hardship to those engaged in fishing, than any other form of protection. Many of those interviewed are enthusiastic in the belief that the work of the Fish Commission is saving the whitefish industry, which would become worthless if the natural form of reproduction was alone depended upon to re-stock the waters.

Several firms were visited at Petoskey. The statements of all were that the supply of whitefish was materially increased, the increase being due to artificial propagation; that with reasonable protection in addition to the work of re-stocking the waters the supply could be increased indefinitely, and one of the most important enterprises fostered by the state restored and maintained to the great benefit of all the people.

The testimony of those interviewed at Traverse City is that not a large number of whitefish are caught there. Refuse and sawdust from the mills has done great damage, and until the depositing of it can be stopped very few whitefish will be caught. Those with whom I talked could not say they believed in artificial propagation of whitefish because they did not see how the results would be determined, the water in which the fry are deposited being so vast in extent. They did, however, believe in the artificial propagation of brook-trout because thousands could be seen in the bay that had come from the Boardman river in which they had been planted by this commission. They see no change in the quantity of whitefish caught from year to year. The number is never large.

The reports received at Manistee show a great scarcity of whitefish, owing to the fact that a large quantity of sawdust is deposited in the water there, destroying or driving away the whitefish. The Fishermen believe in artificial propagation, but do not believe that good results will follow planting there

while so much refuse is being put in the lake. At Ludington the reports received correspond very nearly with those at Manistee. A small increase in the number of whitefish has been noticed, and the fishermen believe that it is due to planting, but do not believe much good can be accomplished until the depositing of sawdust is stopped. Some of these fishermen are familiar with the condition of whitefishing at Frankfort and the Manitou Island, and say there has been a noticeable increase at these places; that the increase is not large but encouraging, and the fishermen there believe the present supply is the result of planting.

Those with whom I talked at Pentwater said there were no whitefish there worth mentioning. They catch lake trout and sturgeon only, and have no opinion as to artificial propagation. What they most desire is to be let alone so far as laws for protection are concerned. They have no objection, however, to having the result of planting thoroughly tested by putting any number of fry in the lake there, but do not want any restriction placed upon the time or manner of catching them.

At Montague, all the reports I received indicate that no kind of fishing is good. Sheepheads, suckers, trout, and a few sturgeon, are the only kinds caught. Whitefishing was once very good there; sawdust and refuse have entirely destroyed it. It is the opinion of all with whom I talked, that planting whitefish fry there will fail to be of benefit, so long as refuse from the mills is deposited in the water.

Reports received at Muskegon and Grand Haven show that there are no whitefish there worth mentioning, the scarcity being due wholly to the refuse from the mills. A few whitefish are caught and the fishermen believe them to have been planted by the commission. They have no doubt that artificial propagation would be a success, if the fry are put into water free from sawdust and refuse.

At St. Joseph, I met a number of gentlemen very extensively engaged, in catching and handling fish; they reported that in 1883 and 1884, quite a large number of whitefish were caught. In 1885, a great rise in the river and a heavy blow carried the refuse from the river into the lake, and in consequence 1885 was a very poor year for whitefishing. In 1886 this refuse began to disappear. Fishing improved and the present season it is very good, with every prospect of still greater improvement. They report the lake there full of small whitefish, too small to be taken with the legal mesh nets which they use. All believe these small fish to be those planted by the commission, and all are firm believers in artificial propagation. I found at St. Joseph some men largely engaged in fishing at Frankfort. From them I learned that whitefishing at Frankfort was very good; not so good, however, as in 1884, 1885 and 1886. They say there are large numbers of small whitefish in the lake at Frankfort and that a great many are caught in legal mesh pound nets by lifting the nets quickly. They are of the opinion that these small fish are planted fish, and they believe in artificial propagation.

The reports at South Haven correspond with those received at St. Joseph. The fishermen believe in artificial propagation, and like those at St. Joseph and Frankfort think the small whitefish in the lake in so great abundance are planted fish. They report a large increase in the number of whitefish there, but on account of the size of mesh used not so many are caught as in former years. They think planting should be continued and increased if possible.

I have also to report that after my return from Lakes Huron and Michigan I visited the southern shore of Lake Erie, stopping at Buffalo, Dunkirk, Erie, Cleveland, Sandusky and Toledo. The statements received at every place were alike and to the effect that the catch of whitefish this season is much greater than in any year for fifteen years; that about five years ago it was the opinion of all engaged in whitefishing there that the supply was exhausted, that the lake was cleaned out, and whitefish in paying quantities would not be caught on that shore again. Whitefish fry were planted in large quantities every spring by the United States, Ohio, Pennsylvania and Michigan Commissions and now whitefish are abundant. Every man with whom I talked was positive and enthusiastic in the belief that the restoration of whitefish to the waters of the southern shore of Lake Erie is due entirely to artificial propagation and the planting of whitefish fry by the different commissions.

A careful analysis of my notes of the interviews with the different fishermen shows as follows:

That at Tawas, Alabaster, Au Sable and Gravelly Point the catch of whitefish in 1887 and 1888 exceeded the amount caught in any year for the past ten years; that the gain has been steady and is the result of artificial propagation. That at Thunder Bay, Alpena and up to Presque Isle while whitefish are decreasing in number, the present supply is believed to be due to planting, and the fishermen believe in artificial propagation without which they think there would be no whitefish at all. That at Cheboygan and Hammond's Bay the whitefish catch has been steadily increasing since 1885, and the season of 1888 is the best since 1885, and the increase is due to planting. At Mackinaw City, Mackinac Island and St. Ignace there has been a noticeable gain, and more whitefish are caught now than for a number of previous years. A great number of small whitefish are seen there, and those engaged in the business believe these to be the result of planting. That at the Chenneaux Island large numbers of very small whitefish are taken, salted and sold for from one to one and one-fourth cents per pound, and ultimately reach the consumer as *herring*. That at Bois Blanc Island the whitefish catch is poor, two-thirds of those taken in the last three years having been very small, and salted and sold as *herring, or thrown away*. The fishermen at these places believe in artificial propagation and that the small fish caught so abundantly are planted fish. That in Lake Michigan above Point Au Chene, fifty miles above St. Ignace, there has been a steady increase for two or three years, and the catch of whitefish in 1888 is unusually good, and that artificial propagation is the cause of the increased supply. That at Mille Coquin Bay there is a marked increase over former years and whitefishing in 1887 and 1888 was good, and artificial propagation is considered a success. That from Mackinaw City to Freedom and Cross Village there is a decided gain due wholly to planting. That at Skillagallee, Little Traverse, Grand Traverse Bay and the Beaver Islands there has been a gradual improvement since 1885; that fishermen noticed the increase and attributed it to the planting of whitefish fry. At Frankfort an increase is also noticed. At Manistee, Lundington, Muskegon, Grand Haven, Pentwater and Montague, while whitefish are scarce in consequence of the depositing of refuse from saw mills, yet the fishermen believe in artificial propagation and that planting would be a success if the water was free from refuse. That at Free Soil whitefishing is good and the supply is due to planting. That on Lake Michigan, from Saugatuck to St. Joseph

and Michigan City whitefish were scarce for some years, but since July 1888 a great increase has been noticed in the number taken of good marketable size. The presence of immense number of small whitefish in the lake has also been noticed by all the fishermen, who consider it undeniable evidence of the success of artificial propagation. And, finally, that the complete restoration of whitefish to the waters of the southern shore of Lake Erie is proof, positive and unquestioned, of the wonderful success attending the planting of whitefish fry in fairly adequate numbers.

A comparison of the statements made at all points visited, with the records of this office, shows that where no planting has been done no whitefish are found or are found in such small quantities that fishing for them is unprofitable, and where comparatively little planting has been done, whitefish are found in paying quantities, while in Lake Erie, where large numbers of whitefish fry have been put they are caught in great abundance and a lost industry restored and made of great profit to those engaged in the business and of great benefit to the consumer by reason of the decreased price of the fish.

Very respectfully,

GEO. D. MUSSEY, *Secretary.*

Detroit, December 1, 1888.

D.—THE FISHERIES.

THEIR REGULATION AND LICENSE.

The necessity of having proper legislation for the protection of the Industrial Fisheries still exists and is made more apparent every year. All that our last two reports have contained on that subject, as to the necessity as well as to the manner of regulation we cannot refrain from urging upon the Legislature; with the single exception that for the enforcement of such laws as the Legislature may enact, we think it would be far more prudent to enlarge the powers of the present State Game and Fish Warden by appropriate amendment to give him substantially the duties and powers we have heretofore urged for an Inspector of Fisheries, instead of establishing another and very similar office. The work of this board has grown steadily and is all that it should be charged with. The duties of the Game and Fish Warden are such that for the next four or five years at least they will require his entire time. The work of each bureau is distinct and can probably be carried on to better advantage to the state as at present organized. This independence of the two departments will not work to the disadvantage of either. Such information as the State Warden acquires (if granted the extended powers which this board thinks he should have) as relates to any work conducted by the Fish Commission, can be readily furnished by him to the commission and will be as available as if procured by its own agents or employés. The additional powers which we think should be conferred upon the State Warden are the inspection of fishing apparatus and markets to prevent or punish the destruction of unmarketable and immature fish; the power of seeking and process for condemnation of unlawful nets and other fishing appliances; more adequate support of that department, which would enable the State Warden to maintain at least two permanent deputies charged with the special duty of looking after the industrial fisheries and procuring reliable statistics of the fishing product. The salaries and

expenses of the deputies assigned to work upon the industrial fisheries should be borne by the state at large, and they should have power to exercise their functions in every county of the state bordering the great lakes and on rivers where the operations of such fisheries are conducted. The able and intelligent efforts of the present State Warden to enforce the law, and the results accomplished in the present unsatisfactory condition of the fishery laws of this state, commend him to the confidence of the Governor and Legislature, and well warrant the granting of more extended powers, the exercise of which promise far more important and permanent benefit to the fisheries and the public interests involved in their preservation and extension than is commonly appreciated by the people.

This matter of regulation of the fisheries and the enforcement of the same is the more urgent as the time has undoubtedly come when the state should adopt a system of licensing the fishing industry. In former reports we have pointed out that one of the conditions precedent to adopting such a system was the demonstration that the state by its artificial propagation and distribution of whitefish could restore the wasted fishing grounds to productiveness, even on the great waters of our bordering lakes. Our anticipations in that direction have been more than fulfilled. In Lake Erie, in the face of the most extensive as well as the most destructive fishing operations, the stock of whitefish has steadily grown since the time that the product of the hatcheries deposited there has had time to mature. The demonstration on Lake Erie, as appears above, has been the most pronounced because there the efforts of the states of Ohio and Michigan have been supplemented by the work of the United States Fish Commission and Canada. The result in Lake Erie has also been most convincing because its extensive fisheries have been in operation longer than those on any of the upper lakes. The reports we have from parts of Lake Michigan, where the artificial planting has been carried on regularly for five (5) years, are equally convincing. The success attained is precisely what we anticipated, and has been of sufficient force to remove every doubt from the minds of the fishermen, and others who have observed the results. A glance at former reports of this board will show that the state fishery authorities had not claimed that all was being done in the way of replenishing the fisheries that could be done, or that ought in time to be done; but only that we are doing enough to show beyond any question that the artificial methods adopted by the state could stay the waste and the depletion of the fisheries in the localities selected, and make a complete demonstration that would justify the state in engaging more extensively in such operations; in fact upon a scale that would increase the product of the fisheries many times in value. The fact that the extent to which the production of whitefish can be carried is only limited by the capacity of the great lakes to furnish food to grow the fish, means that the actual value in money of the product that our waters will yield annually can be reckoned in the millions of dollars, and, also, that this industry fostered by the state can by a just system of license pay all the cost of producing the annual supply of young fish, as well as the expense incurred by the state in regulating the industry.

The proceeds of any license system adopted by the Legislature should in our judgment be apportioned by the State Treasurer between the State Warden and this Board, taking for the former all the expenses incurred in the inspection and regulation of the industrial fisheries, and the remainder

should be placed to the credit of the Fish Commission and used by it exclusively in extending its operations in the hatching and distribution of whitefish to the great lakes.

III.—ARTIFICIAL PROPAGATION AND PLANTING.

1.—WHITEFISH.

The great importance of the commercial fisheries of Michigan, furnishing employment as they do annually to a large number of men and requiring the investment of large sums of money to conduct them, demands of those engaged in the artificial propagation of fish, especial attention and the exercise of every effort to restock exhausted waters. By a reference to the statistics contained in the last biennial report of this board, it will be seen that the amount of money annually brought into the State derived from the sale of whitefish amounts to nearly or quite $1,000,000, as near as can be ascertained, although we are satisfied, from the difficulty of collecting reliable information on the subject, that this amount is considerably below the actual amount realized.

It is therefore of the first importance that the Michigan Commission in the conduct of its work should give special attention to the restocking of the great lakes and their connecting waters, which have been greatly depleted by constant fishing without limitations as to the capture of small and immature fish, since the settlement of the state.

It must be remembered that the improvements in the apparatus for taking whitefish have been greatly multiplied in the last ten or fifteen years, and that the destruction of the whitefish has more than kept pace in most localities with the effort to restock the waters. The business of fishing previous to the last decade was largely prosecuted with Mackinac boats and was carried on near the shore, but the business has been so revolutionized by newer and more destructive modes of capture, that the business as now conducted has fallen into the hands of men of larger means, and the fishing is now prosecuted by the use and employment of steam craft, and much of the fishing is done far from the shore.

As a consequence of this change the destruction of the whitefish has been quadrupled many times. The establishment of depots where fish may be frozen and preserved for future use, has within the last few years offered a temptation to those engaged in the business to prosecute their work during almost every season of the year, when not rendered impracticable by storms or other unfavorable conditions. Very many localities formerly known as good whitefish fishing grounds have by the multiplication of methods of capture been fished to death and now make but poor return, if any, to the fishermen, while many other grounds have been wholly abandoned because of their unproductiveness.

The vast extent of lake coast of the state causes it to stand first among the states bordering on the great lakes in the importance of her whitefish fishing industry, and the demands upon the Michigan Fish Commission for the reasons above referred to have been so imperative, and the product of the fisheries has been so profitable to those interested directly and indirectly in them that every effort has been exerted upon our part to enlarge to the fullest extent the possibilities of artificial propagation.

With an extent of coast of lake and river covering 2,000 miles, it can be imagined that the impression made by the commission in restoring unproductive waters, for the first few years of its existence was trifling. Hampered as it was by lack of means, methods and experience, the result of its work annually was insignificant as compared with the present output. Artificial propagation of fishes was then a new and in a large measure an untried experiment as to practical results, and comparatively small quantities of fry were placed in the great lakes up to the time of the completion of the new whitefish hatching station at Detroit in the year 1883, and the erection of the whitefish station at Petoskey in the same year. Since 1883 the work has been greatly increased and with the number of fry annually put into the waters of the great lakes the results of these plants must soon be manifest in all the waters, as recent results have shown its success in Lake Erie.

Prior to 1881 the method for hatching whitefish was by the use of trays, and the work that could be done in this manner was necessarily limited as to output, for the reason that it required one employé to every million of eggs thus cared for. But in 1881 the introduction of the Chase automatic jar entirely revolutionized the methods theretofore employed, and made the hatching of very much larger quantities practicable with a minimum amount of cost. By this device economy in labor has been gained until now, with the employment of two men during the hatching season, 100,000,000 whitefish eggs can be cared for, while the same number of eggs by the use of the old method would have required the attention of at least 150 persons.

In inquiring into the results of the efforts made to restore the waters of the great lakes to a condition where profitable fishing may be done, it must be borne in mind that while large numbers of fry have been put into the waters every year in good condition, they must necessarily run the risk of loss from predacious fishes and other natural enemies, and that the losses sustained in this manner must cut a large figure in determining what proportion will live to reach the spawning age. Increased facilities of capture, the duplication of nets, the smallness of the mesh of nets used by which the small fish are taken for market before coming to the age of maturity where they may reproduce their kind, are all elements which very materially affect the results of a re-stocking of the waters. It may be suggested in this connection that the enforcement of wholesome and proper regulations for the preservation of the smaller fish which are of little or no value in the market, might well occupy the attention of the law-making body, and that the State has a right to insist that its efforts to re-populate the waters shall not be counteracted by improper and unreasonable modes of capture.

2.—BROOK-TROUT.

The hatch of brook-trout at the Paris Station in the winter and spring of 1887, was the largest in the experience of the commission up to that time.

The first eggs were taken Oct. 4, 1886, and the egg-taking continued until January 15, 1887. The larger proportion were taken as usual during the month of November.

The first eggs of season 1886–87, hatched on the 6th day of December, 1886. Only a very few, and those of the eggs first taken in the early days of October, however, hatched so early as December; the overseer's report of January 15, 1887, shows that up to that time only 80,000 were out of the

egg. The hatching continued until April 15, 1887. This is probably the longest period of incubation that has been experienced at Paris Station, being 23 days longer than required in the following year, when about one-third more eggs were handled. The first trout were shipped out for planting on February 21, 1887, and the last shipment was made May 24. The total number of brook-trout eggs taken this season was 1,310,500. The number of females stripped was 3,460, giving an average for each female of 378.76. At that time there were about 7,600 trout in the stock ponds, 4,140 males and 3,460 females, over two years old. This average yield of eggs is quite low, and is readily accounted for by the great number of young fish in the ponds. The total number planted was 1,090,000.

The loss of eggs during the incubation of this year was about ten per cent., and the loss on young fish while being carried till the unbilical sac was absorbed was about seven per cent., or total loss from the eggs and young fry about 17 per cent. This is a very good average, particularly when account is taken of the crowded condition of the troughs and trays. In hatching and rearing young trout for planting, the greatest difficulty is in the handling of the recently hatched fry. The umbilical sac of the brook-trout—that provision of nature for the sustenance of the fish during its period of helplessness—is large and heavy in proportion to the size of the body, so that for the first weeks the fish is scarcely able to keep himself afloat in the water, and spends the greater part of its time resting on the gravel, or wire screen bottom of the tray. The hatching fish consequently require much more room than the eggs. The capacity of a hatchery is predicated upon the number of young fish that can be safely carried to the planting age—30 to 50 days—not by the number of eggs that can be carried through the period of incubation. By March, 1887, the old hatchery at Paris was crowded beyond the point of convenience or safety. Fortunately there was no bad weather or other accident to prevent rapid shipment of fish, and the ratio of loss was less than in former years, owing largely to the experience and watchfulness of the overseer and his assistants. The average temperature of the water from October 4 to March 5 was 37°. They were distributed to the following named counties: Allegan, Alcona, Antrim, Arenac, Barry, Berrien, Branch, Calhoun, Cass, Charlevoix, Cheboygan, Clare, Eaton, Emmet, Genesee, Gladwin, Grand Traverse, Ingham, Ionia, Isabella, Kalamazoo, Kalkaska, Kent, Lake, Lapeer, Lenawee, Livingston, Manistee, Oakland, Oceana, Osceola, Ottawa, Roscommon, Saginaw, St. Clair, Shiawassee, Van Buren, Washtenaw, Wayne. In all forty-four counties. The number of streams planted being about one hundred and seventy. In streams of large size, say of five to seven miles and upwards in length, experience has shown that the best results are obtained by making plants on two or three successive years. With an abundant supply of fish there is no reason why this should not be done. In a river like the Boardman or Jordan frequent plants should be made, as those streams are capable of supporting a very large number of trout, and even if the food supply of the fish should be temporarily overtaxed, there is an opportunity for the fish to range into the lakes below, as they are known to do, where plenty of food will be found, and a large growth attained.

In the fall and early winter of 1887, the first trout eggs were taken on the 30th day of September, and the yield continued until the 11th day of January, 1888. The highest number taken on any one day was 123,000, on

November 2. The first fish hatched on the 12th day of December, and by the 28th day of March all were out. The total number of eggs laid down that season was 1,952,000. The total number of fish planted was 1,639,000, showing a loss of only 16 % which marks it at the most successful hatch ever made by the commission. This was attributed to the fact that it was the first season of the new hatchery (a full account of which is given below under the appropriate head) and the young fish were afforded ample room. The loss in young fish after the hatching, and while they were being carried until they were old enough for planting, which is far the most critical period in the young trout's life, was remarkably small.

Planting was begun on the 26th day of February, and finished on the 14th day of April. The handling of so large a number of trout impressed most strongly upon the board the immediate necessity of a car properly constructed and equipped for the safe, convenient and economical shipping of our trout, as well as other fish.

The number of brook-trout in the ponds in January, 1888, over two years old was 10,000; the number of females stripped was 4.817, showing an average yield of 405.231 for each female. The number of males was 5,183. The increase in average yield of eggs to each female, over the average yield of 1886 was 26.471. Between May and November, 1887, 3,906 brook-trout of various sizes, mainly two and three years old, were caught in the wild ponds and creeks on the state property, and were distributed to the stock-ponds. This is quite satisfactory evidence that our stock fish will receive quite large additions each year from these sources, and that we shall not be entirely dependent upon the rearing of young fish for that purpose in the nursery races and in the ponds.

In December we sent 25,000 brook-trout eggs to the Hatching Station of the United States Fish Commission at Northville, Wayne county, in exchange for the same number of eggs of brook-trout delivered by them on 16th February following. This exchange is for the purpose of introducing new blood. For that purpose the fish hatched from the eggs then exchanged will be kept and reared at Paris for breeding.

The young brook-trout of this season, the spring of 1888, were distributed to the following named counties: Allegan, Alpena, Antrim, Branch, Barry, Calhoun, Clare, Cheboygan, Cass, Clinton, Charlevoix, Crawford, Eaton, Emmet, Genesee, Grand Traverse, Hillsdale, Ionia, Ingham, Iosco, Isabella, Jackson, Kent, Kalamazoo, Kalkaska, Livingston, Lenawee, Lake, Lapeer, Mecosta, Montcalm, Macomb, Mason, Manistee, Muskegon, Marquette, Newaygo, Ottawa, Osceola, Oakland, Ogemaw, Saginaw, Van Buren, Wexford, Washtenaw. In all 46 counties. The number of streams in which plants were reported this year was 244. The number of persons supplied with trout on regular application was 162. The Jordan, the Cedar, the Boyne, the Boardman rivers and Carp lake, and two brooks in Mecosta county were planted by direction of the Board.

The number of streams planted was 106, in 1886, on 77 applications; in 1887, 163 streams were planted on 118 applications. The increasing number of applications from so many citizens is some indication of the appreciation on the part of the people of the state of the work of fish-culture. In considering the number of applications one must not fall into the error of supposing that each application represents only the applicant, for in nearly every case he represents a community. Often the applications are filed by a

number of citizens joining together for the purpose of securing something of common interest to many; frequently applications are made by clubs.

As this report goes to the printers' hands reports from the Paris Station shows that over 2,500,000 brook-trout eggs have been taken from the stock-fish, and a reasonable estimate promises to make the total this season of 1888 reach 2,850,000. This more than makes good the anticipation of the past two years.

3.—LAKE, OR SALMON, TROUT.

As announced in our last report, operations with the salmon trout had been temporarily suspended, partly because other work seemed more urgent, and until the completion of new hatchery at Paris, there was not enough available room in the troughs for handling any; but mainly in order that through the examinations of inland lakes we might learn as definitely as possible what had been the results of planting them in 1884 and 1885 in some small interior lakes. And, also, because the examination of inland lakes had not proceeded far enough to enable the board to decide what number of salmon trout could be used advantageously. We have now facilities for doing all in this line that may be proved to be desirable. The examination thus far has shown a number of lakes in the southern part of the state which are undoubtedly well adapted to rearing the lake trout, both because of their depth and the temperature of the water, and the existence in them of herring, which in the great lakes constitute a large share of their food.

4.—WALL EYED PIKE.

Among commercial fishes the wall-eyed pike, by reason of its edible qualities, ranks among the first. It enters largely into the food consumption of the people, and forms quite a percentage of the value of the marketable fish of the state. It is a spring spawner, and like all spring spawners, the period required for the hatching of the fry after the egg-taking or fertilizing process requires a much shorter time than is needed for the fall spawners. The average time required for the hatching of the fry after fertilization with wall-eyed pike is from 17 to 23 or 24 days, while with the fall spawners, like the whitefish, this time extends over a period from 100 to 130 days.

The wall-eyed pike begins to run in our rivers in May and June, varying somewhat with locality, and are most largely taken in the St. Clair and Saginaw rivers and bay. The larger portion of the eggs taken by the commission have been obtained from one or the other of these localities.

Much greater difficulty is experienced with the handling of wall-eyed pike eggs because of their being extremely viscid and having a tendency to cake or mass together, which can only be overcome by manipulation of the operator or spawn gatherer. Because of this tendency the percentage of impregnation is much lower than is experienced with the whitefish and brook-trout, so that in handling a given number of eggs the net result of impregnation is very largely in favor of the last two mentioned varieties. Another and serious difficulty with the hatching of the wall-eyed pike is encountered immediately after the fry is hatched, and while it seems almost incredible, it is a fact that they prey upon each other, and at almost any

time during this period of the operations it can be observed with the naked eye that each individual is trying to swallow his fellow and large numbers are lost in this way. This can only be overcome by making the plants at the earliest possible time consistent with safety after they are hatched.

While the work of hatching the wall-eyed pike has not been conducted for a sufficient length of time to warrant much return of evidence of the success of stocking the waters, yet we have been furnished with quite a number of evidences of success in this direction, and we look for their successful introduction into the inland lakes of the state, where they will constitute a large item of food. The board is receiving many applications for this fish, and steps are being taken to supply the demand as rapidly as possible.

The spawning period of the wall-eyed pike following as it does very soon after the completion of the plants of whitefish and brook-trout, permits the employment of the regular force so far as required in the carrying on of this work, and as the period from the season of egg-taking to the time of planting is comparatively short, covering only about two months, this work is usually completed by the first week in July.

The eggs of the wall-eyed pike are considerably smaller than those of the whitefish. An actual count of these eggs was made in the spring of 1888 and resulted as follows:

Number of eggs to the square inch, 2,197.

Number of eggs to the quart, 152,292.

Average number of eggs to a jar, 304,583.

The above figures were ascertained by actual count and can be relied on for accuracy.

In the spring of 1887 the egg-taking operations were conducted at Bay City, and the eggs were taken to Petoskey and hatched in the Chase jar at that station. The total number of eggs taken was 6,000,000 and the total number of fish planted was 3,280,000.

The fry were distributed in the counties of Branch, Eaton, Hillsdale, Kent, Kalamazoo, Lenawee, Emmet, St. Joseph, Wexford, Washtenaw and Osceola.

In the spring of 1888 the spawn was gathered at Linwood, on Saginaw bay, and at Port Huron, on the St. Clair river, and were shipped to the Detroit station, where they were hatched and from which point they were distributed.

The total number of eggs taken was 24,000,000. Of this number there were hatched and distributed 11,492,000 in the counties of Branch, Cass, Calhoun, Clare, Cheboygan, Genesee, Hillsdale, Ionia, Ingham, Jackson, Kalamazoo, Livingston, Lenawee, Macomb, Montcalm, Oakland and St. Joseph.

It will be observed that the percentage of loss was very high, although we believe that the percentage hatched is as high as that reached by any other commission in handling these eggs. The reasons for this loss have been above stated and need not be referred to again.

Very much difficulty is experienced in obtaining the spawn of these fish, as they are somewhat erratic in their spawning habits and it is impossible, owing to the shortness of the season, to always be upon the ground at the right time. It very frequently happens that the fish in Saginaw Bay and river spawn from one to three weeks earlier than the fish in the St. Clair river, although the latter stream is considerably further to the south. In the spring of 1888 the force was first sent to Saginaw Bay, but it was soon learned that the fish at

that point had already spawned and the force was transferred to the St. Clair river and Lake Huron.

Tabulated statements of the plants of the wall-eyed pike can be found in the appendix.

It should be stated here that owing to an accident to the water works at Petoskey in May, 1887, whereby the water supplying the house was interfered with, the eggs were very badly injured, and undoubtedly the percentage of success was considerably diminished for this reason.

5.—CARP.

There has been an increasing demand for carp since our last report, but nearly all orders have been filled, and this year many more might have been furnished on application.

The time since the carp was introduced in this state has been so limited, that but little can be said as to the ultimate result of the cultivation of this variety as a food fish, for with the present generous supply of our undoubtedly much better native fish, the question of the value of the carp will wait for its solution in the future; but the time is coming when the question of a supply of food for our better fish, notably the black bass, may find its solution in the wonderfully prolific powers of the carp. The quantity of fish that any given area of water can supply must to a great degree depend upon the quality and amount of food that the fish can find therein, and the time may come when to supply fish for the food of other fish may become an important part of the work of the commissions as is the present of fish in new and depleted waters; and in such an event the carp may come to assume a very important place in fish culture in America.

6.—BLACK BASS.

Distribution of Bass.

Many of the inland lakes of the state are naturally well stocked with the small-mouthed black bass, which stands without rival as a game and food fish, while other lakes well adapted to their habits are either now depleted of this variety, or in the original distribution by nature, never chanced to be stocked with them. The board has long had in contemplation the stocking of these waters with this valuable fish, but for lack of means by which they might be transported they have never been able to accomplish such restocking. The black bass is so radically different from almost all of the other fresh-water fishes in its spawning habit and in its watchful care over its ova and fry, that the percentage of loss of eggs cast in the natural way and of the fry when hatched is very much smaller than with most of the fish of our northern waters. It is a well established fact that the parent fish hover about the spawning bed constantly, from the time the eggs are cast, until the fry has been hatched and are in measure able to take care of themselves. This will largely account for the presence of this fish in nearly all our fresh-water lakes and streams, and for its wide distribution over the greater part of the United States.

For the reasons above stated these fish have never been artificially propagated, other than for the purpose of experiment, and it has been found that better

results can be reached by making the distribution of young fish, either yearlings or two year old, from one water to another. This work will be carried on during the late summer and fall of every year, the new car now at the command of the board enabling us to reach every part of the state where it is desirable and advantageous to make distributions of this fish. Owing to the lateness of the season, when the new car was received the distributions have been necessarily small this year, but the little experience we have had has demonstrated beyond doubt that the fish can be held in cans and the temperature of the car so reduced that without a change of water bass may be carried from any point in Michigan to San Francisco or any other remote part of the union, if necessary. Below will appear in detail the work done for the fall of 1888, in the distribution of black bass.

On the 12th of September Mr. A. W. Marks, the overseer of the Detroit station, with six assistants, left Paris with the car for Edwardsburg, in Cass county, to commence the taking and distribution of the small mouthed black bass. They arrived at Edwardsburg, near Eagle lake, at 3 A. M., side-tracked the car and established a camp at that point and proceeded to take the fish needed for distribution. The fishing was done with a small mosquito-bar seine, the men wading into the lake and drawing the seine near shore. After the seine was drawn, the fish were removed and placed in crates. The fish varied from two to three or four inches in length. Crates had before been prepared to receive the fish, being made of dry-goods boxes with a lid upon the top, which could be opened and closed at pleasure, and having a fine wire screen at each end, allowing free circulation of the water in the box and preventing the fish from escaping. The fish were held in these crates until a sufficient number had been procured for shipment, when they were removed from the crates and placed in the shipping cans in the lockers of the car, ready to be taken to point of destination.

The car left Edwardsburg with first shipment of 650 small-mouthed black bass on September 18, and they were distributed as follows:

September 18—	
Cass county, Cassopolis, Stone Lake	75
Cass county, Marcellus, Fish Lake	50
Kalamazoo county, Scotts, Scott's mill pond	50
Calhoun county, Battle Creek, Goguac Lake	200
September 19—	
Eaton county, Bellevue, to D. Hart	50
Jackson county, Jackson, to Geo. E. Beebe	75
September 20—	
Hillsdale county, Bawbeese Lake	100
Jackson county, Brooklyn, Clark's Lake	50

The car then returned to Edwardsburg, September 21, at 11 A. M. In the afternoon of the 22d it was found that the wind was killing the fish in the crates in the lake, and the camp was broken and everything was removed to the car. Another reason for removal was the lateness of the season, the young fish having moved into the deeper water, where it was impossible to take them with the net. The "Attikumaig" left Edwardsburg September 24, at 1:30 P. M., for Petoskey, via. Detroit, with the remainder of the catch of black bass taken after the first plant, 900. The car was sent to Detroit, as it was

desired to store the boats, camp equipage, etc., at the Detroit station for the coming year. The plants made upon this trip were as follows:

September 24—	
St. Joseph county, Colon	200
September 25—	
Branch county, Coldwater, Coldwater Lake	100
Branch county, Quincy	50
September 26—	
Oakland county, Birmingham, to Chas. D. Place	25
Oakland county, Lakeview Lake	100
Genesee county, Fenton	50
Kent county, Sand Lake	26
September 27—	
Charlevoix county, Clarion, Bear Lake	150
Emmet county, Levering, Douglass Lake	150

These fish were taken from the lake at Edwardsburg at 8 o'clock A. M. September 23, were taken to the car in cans, each can containing about 150 fish. After being received at the car the fish were divided, about 25 fish being put into each can. The time occupied in making these arrangements was up to noon of that day. At this time the temperature of the water in the cans was 60 degrees, and the temperature of the air was 80 degrees. After being divided in the cans, the cans were placed in the lockers of the car and broken ice was packed around the cans, this work being finished at 12:30 P. M. At 3 P. M. the temperature of the water had fallen 12 degrees and was gradually lowered until it reached 40 degrees, which was the lowest point indicated by the thermometer at any time during the trip.

The smaller fish were carried successfully and without loss. An experiment was made with larger bass, which was not so successful. Thirty-four bass weighing from a quarter of a pound to half a pound each, were placed in the car, but they commenced dying on the night of the 24th, and when the car reached Detroit on the morning of the 26th they were all dead. This failure to carry the larger fish is attributable to the fact that for lack of room they were much crowded in the cans. There is no question that with one or two fish placed in each can the larger fish can be transported with equal success.

The fish were carried without change of water, some of them being in the cans four days, being taken from the lake on the 23d, and not planted until the 27th. All the young fish were in good condition on leaving the car.

The examination of waters, which has been conducted by the commission for the last three years, shows out of 154 lakes examined, about 20 contained small-mouthed back bass and about 130 contained none at all, the most of which are well adapted to the habits of these fish. We are of the opinion that the distribution of the small-mouthed black bass in the waters of the different parts of the state will meet with general approval of the people and will greatly popularize the work of the commission.

7.—GRAYLING.

A reference to the last biennial report will show that measures were taken by the board in 1886-7 to successfully hatch and artificially propagate the

grayling. All former experiments in this direction had resulted in failure, which was largely owing to the fact that the grayling will not stand domestication.

In order to overcome this difficulty nearly 400 feet of stream on the Buckhorn creek on the state property at Paris was set apart for an experimental pond. This part of the stream was left almost in a state of nature, nothing being done beyond what was demanded to confine the fish within these limits. We believed under these circumstances, the conditions being so favorable and the fish being relieved largely from restraint, that at the proper season they would show a disposition to spawn, when they could be removed and the ova taken.

In August, 1887, an expedition was organized to the west branch of the Manistee river, where a camp was established and a sufficient force went up the river to secure the stock needed for the pond. About 300 grayling were taken and from this number there were selected and sent to Paris eighty-five grayling in good condition. As the spawning season approached they were closely watched, but gave no indication of spawning whatever. The result has been that this experiment has resulted in another chapter of failure in the propagation of the grayling.

Upon consultation it was deemed advisable by the board to make one more experiment under the same general plan. Accordingly, on the 10th of August, 1888, another force was sent to the same place upon the west branch of the Manistee river. The weather was very unfavorable owing to heavy rains, and but about one-half of the number of grayling were taken in a nine days' stay, of the number taken the year before. From the number taken there were successfully transported to Paris, 66 adult grayling, which arrived there in a healthy condition.

With these fish and those already in the pond, we shall conduct the experiment for another year, we trust with better results, although the encouragement is not great.

8.—LOCH LEVEN TROUT—THE TROUT OF THE SCOTCH LAKES.

By the courtesy of the United States Commissioner of Fish and Fisheries, we received on December 21, 1887, a consignment of 15,000 eggs of the Lock Leven trout, from the Cold Spring hatchery, Long Island. They were part of a batch imported by the United States Fish Commission. February 16 the young fish began to hatch out. During incubation 5,165 eggs were picked off, a loss of about 34 per cent. The survivors, about 9,000, were planted on the 24th day of May in Torch Lake.

The Loch Leven trout in its native waters is not only excellent food, but a first-rate game fish, and if it proves practicable to establish this variety in some of our colder interior lakes, will prove a great addition to our list of food fishes.

9.—LAND LOCKED, OR SCHOODIC, SALMON.

The efforts of the commission to prosecute the experiment of acclimatizing the fresh water salmon in Michigan waters has continued during the time covered by this report, as earnestly as opportunities would permit. As explained in former reports, the eggs of the land locked salmon have been given to us by the United States Commissioner of Fish and Fisheries from

the proceeds of a joint operation of that commission and some of the New England States, conducted at Grand Lake Stream, in the State of Maine. The proportion of the product of eggs from that station is not very large, and Michigan has been treated very generously by the United States Commission in making the distribution of its share of them.

There was received at the Paris station a shipment of schoodic salmon eggs on the 14th day of March, 1887, numbering 25,000. While the number seems small for our purpose, we were nevertheless thankful to receive them. The date at which they were received was somewhat later than usual, and on opening the package some of the eggs were found to have hatched. There were 247 dead eggs picked off on the arrival of the box. It may be remembered by former readers of the reports that the schoodic salmon eggs received from Grand Lake Stream are taken in October, or November, carried in troughs until the latter part of February, or first of March, and then, after the percentage of bad eggs has worked off and the eggs are nearly ready to hatch out, they are packed in a skillful manner and shipped to their various destinations. By April 13 the salmon eggs were all hatched. The umbilical sac was gone from the young salmon on May 14, and on the 19th they were planted. The total loss on this lot of eggs was 1,364, 247 being found dead on opening the package and 1,364 only were lost in the final process of incubation and in carrying the young fish until ready for being planted, the loss being a little over $6\frac{1}{3}$ per cent. The temperature of the water used in hatching was 40° Fah. The young salmon were principally planted in Torch Lake and its tributaries. Torch Lake was selected for the experiment on account of its depth, temperature, the purity of its water, and the existence there of other fish of similar feeding habits, which indicated the presence of proper food for the young and for the growing salmon. Torch Lake is about 18 miles long and from one-half mile to one mile wide, almost entirely fed by springs and has very bright, clear water. The ultimate purpose in introducing the schoodic salmon is to make the attempt to establish them in the Ste. Mary's river, the Straits of Mackinaw and the northern waters of Lakes Huron and Michigan and Lake Superior, as well as to stock some of the larger and deeper interior lakes, like Torch, Bear and Higgins. But in order to obtain the young fish in anything like adequate numbers for the former purpose we must first rear them in sufficient quantities to procure the eggs, as we cannot get enough of them from the Maine lakes to make any impression on those large waters.

There are a few schoodic salmon in the ponds at Paris. A very few eggs were taken from them in the fall of 1887, but they failed of proper impregnation. The ova seemed to be in an unhealthy condition when taken from the fish.

On March 10, by the courtesy of the United States Fish Commission, we received from them a still larger consignment of schoodic salmon eggs, numbering 75,000. They were as usual in excellent condition. On opening the cases only 60 dead eggs were found; during incubation 643 were lost; and in rearing the hatched fish until they were planted 933 were lost, making a total loss in of only 1,636, or a percentage of less than $2\frac{1}{4}$. The temperature of the water when the eggs were placed in the trays in March was at 34 degrees and rose gradually, with the fluctuations usual at Paris station, to 40 degrees. The young salmon fry were planted May 24 in excellent condition, 73,424 in number, mainly in Torch Lake, where they have been

deposited for the past five years. In planting this year some of the fish were placed in the lake itself, some in small spring brooks flowing into the lake. It is hoped that the examinations to be made at Torch Lake will determine something definite as to the success of the planting of salmon in that water. The temperature of the moss in which they were packed was found on opening to be 50 degrees. The young salmon began to hatch on April 2, and were all out by April 15.

10.—CALIFORNIA, OR MOUNTAIN TROUT.—(*Salvelnius Irideus.*)

In the last report (p. 37) it was stated that the adult California trout were deposited in the Muskegon river, owing to a threatened loss of them by an insidious disease which did not yield to such treatment as could be given them. This was in August, 1886. In the following spring, May 14, nine or ten of these fish came from the Muskegon into Cheney creek and spawned naturally. Reports have been heard of quite a number of them that had been caught with hook and line in the river, and several of them have been caught near the station and placed in the pond with the largest sized brook trout. On March 22, 1887, we received from the United States Commission station at Northville 25,000 eggs of this trout. They were hatched by April 20. On May 10 they were feeding, and May 17 they were planted, numbering 20,000, in tributaries of the Muskegon river, near Paris.

11.—GERMAN OR EUROPEAN TROUT—THE SAIBLING—(*Salvelinus alpinus*).

The U. S. Commission sent us from its Northville Station in March, 1887, 25,000 eggs of the German trout. The eggs came in good condition and were hatched by April 13. April 20 the young fish were taken from the trays and placed in troughs on fine screened gravel. By May 10 they were feeding, and made rapid growth. They were placed in the nursery races, and are kept for a pond of stock fish. Another gift of German trout was made by the U. S. Fish Commission December, 1887, when the U. S. fish car brought the Loch Leven trout eggs, consisting of 500 yearling fish and 5,000 eggs, March 12, the eggs were all hatched out, 1,023 having been picked off dead, making a loss of 20%.

The German trout or saibling is closely allied to our brook-trout belonging to the same genus, Salvelinus. Dr. David Starr Jordan in his article on "The Salmon Family" in his admirable book entitled "Science Sketches," says: "The genus Salvelinus comprises the finest of the Salmonidæ, from the point of view of the angler or the artist. In England the species are known as char, in contradistinction to the black species of Salmo, which are called trout. The former name has unfortunately been lost in America, where the name "trout" is given indiscriminately to both groups, and still worse, to numerous other fishes wholly unlike the Salmonidæ in all respects. It is sometimes said that the American brook-trout is no trout, nothing but a char, almost as though char were a word of reproach. Nothing higher, however, can be said of a salmonoid than that is is a char. The technical character of the genus Salvelinus lies in the form of its vomer. This is deeper than in Salmo; and when the flesh is removed the bone is found to be somewhat boat-shaped above, and with the shaft depressed and out of the line of the chevion. Only the chevion is lined with teeth, and the shaft is covered by skin.

"In color all the chars differ from the salmon or trout. The body in all is covered with round spots which are paler than the ground color, and crimson or gray. The lower fins are usually edged with bright colors. The sexual differences are not great. The scales in general are smaller than in other Salmonidæ and they are imbedded in the skin to such a degree as to escape the notice of casual observers and even most anglers.

"The chars inhabit, in general, only the clearest and coldest of mountain streams and lakes. They are not migratory, or only to a limited extent. In the Northern regions they descend to the sea, where they grow much more rapidly, and assume a nearly uniform silvery gray color. The different species are found in all suitable waters throughout the northern parts of both continents, except in the Rocky Mountains and Great Basin, where only the black-spotted trout occur.

"The only really well authenticated species of char in European waters is the Red Char, Saibling or Ombre Chevalier (Salvelinus alpinus). This species is found in cold, clear streams in Switzerland, Germany and throughout Scandinavia and the British Islands. Compared with the American char, or brook-trout, it is a slenderer fish, with smaller mouth, longer fins, and smaller red spots, which are confined to the sides of the body. It is a gregarious and deep swimming fish, shy of taking the bait and feeding largely at night time. It appears to require very pure and mostly deep water for its residence. It is less tenacious of life than the trout. It reaches a weight of from one to five pounds, probably rarely exceeding the latter in size."

IV.—THE HATCHING STATIONS.

THEIR EQUIPMENT AND NEEDS.

1.—The Detroit Station.

The entire work of spawn gathering of whitefish of the Commission has been carried on for the last five years upon the Detroit river. It has been found by experience that this work can be more economically conducted on the Detroit river than elsewhere in the State. This is so because of the nearness of the fisheries to the Detroit station, and from the fact that the waters of the river are more sheltered than those of the open lakes, and the fish can be crated and kept until fit for handling in sheltered places, while it would be impracticable and impossible to carry on these operations at other and more exposed localities.

Because of these reasons we have deemed it best to discontinue the use of the Petoskey station for the present and confine the entire work of whitefish hatching to the Detroit station. From this point distributions can be made of the fry to as good, if not better, advantage than from any other point in the state. By this arrangement too the force formerly necessary to conduct the Petoskey station can be dispensed with, while the efficiency of the work will, we believe, be much increased. Such necessary changes have been made at the Detroit station as to accommodate the jars formerly carried at the Petoskey station, and for the present, the work heretofore conducted at Petoskey will now be done in Detroit.

The seventh biennial report closed with December, 1886, and a resumé of the work from that date down to Dec. 1, 1888, will now be given.

The whitefish spawn taken by the commission in the fall of 1886 to fill the Detroit and Petoskey stations, was all taken on the Detroit river from fish taken on the fishing grounds at Fort Wayne, Grassy Island and Bois Blanc Island. The total number of fish taken upon these grounds and handled was 6,494. The season was a poor one, severe storms interfering with the work, and at the Bois Blanc fishery, on account of the severe storms on the 18th of November, the fish in the crates at that point were lost, there yet remaining in the crates 358 unstripped females. Of the eggs taken from these fish, 31,000,053 were taken to the Petoskey station, and 47,424,000 to the Detroit house.

In order that a definite idea might be formed of the quantity of eggs being handled from year to year, it was determined by the Board to definitely determine, by actual count, the number of eggs in a given measure upon which estimates could be safely based. A pint of whitefish eggs were counted out and the number ascertained, and the jars in the houses being filled by measure a very close determination was thus made of the entire number taken. Upon this count it was found that a pint of whitefish eggs contained 18,300 eggs, and from this count the total number put in both houses was found to be 78,477,000. Of this number there was hatched and distributed from both stations 72,974,000. The details of the plants made are shown on the table of whitefish plants annexed to this report. The general result of the fishing upon the Detroit river during this year was very poor and unfavorable.

For the egg taking season of 1887–8 arrangements were made for the taking of spawn at Fort Wayne and Grassy Island fisheries upon the Detroit river. It was apprehended by the commission soon after the season's operations began that the fishing would be light, and that other arrangements must be made to fill the houses by securing additional fish. An arrangement was therefore made, after the fishing season had opened, with D. W. & S. H. Davis, for the handling of the fish taken by them at the Belle Isle fishery near Detroit. The season proved to be a very unfavorable one for holding the fish in the crates, which resulted in a considerable loss, and owing to the lateness with which the arrangement was made with the Davises for handling their fish, the season's operations resulted in a very much enhanced cost to the board in securing the necessary spawn for the season.

After the fishing season had commenced, it was found that the catch of fish was larger than had been anticipated, and much larger than it had been for several years. There was also a noticeable increase in the number of small fish taken. It was also observable that a large number of the females were spawning this season for the first time. As a result of the fall fishing the fishermen who had had twenty years' experience upon the river were uniformly of the opinion that the increase in the number of fish taken was the result of the plants made by the commission in former years.

The total number of eggs taken this year was 94,996,394. Of this number there were taken to the Detroit station 48,315,000 and to the Petoskey station 34,352,000.

In addition to these amounts there were taken and donated by this board to the United States Commission 12,329,394. This allotment was made to the United States Commission because of their inability to secure facilities during the season of egg taking to enable them to fill their houses. In return for this courtesy the United States Commission subsequently gave to the

Michigan Commission a large number of eggs of the land-locked salmon and of the German brown trout, as shown in another part of this report.

From the eggs sent to the Detroit and Petoskey stations there were hatched and distributed the following amount: From the Petoskey station 29,968,000 and from the Detroit station 43,000,000. The details of the distribution of these young fish shown by the tables in the appendix, together with the temperatures of the water at the different stations throughout the hatching season.

During this year about 12,000,000 eggs of the wall-eyed pike were hatched at the Detroit station and they were distributed at various points in the State, as shown by the table of wall-eyed pike plants in the appendix to this report.

During the summer of 1888 the Detroit station, buildings and fences have been repainted and a suitable sign has been placed upon the building, and some other minor repairs have been made.

Late in the spring of 1888 and nearly at the time when the whitefish eggs would begin to hatch an accident occurred to the water supply of the Detroit house which threatened serious results: anchor ice formed at the inlet pipes of the Detroit water works, shutting off the supply of water at the house and all over the city. For two hours and 53 minutes the constant supply of water which is necessary for the work was shut off from the Detroit station, and as a result fifty-three jars of eggs were prematurely hatched. But as it was near the hatching season, and as at the end of this time a fresh supply or water was obtained, there was comparatively little loss. Such of the fry as were hatched at this time proved to be strong and vigorous and the loss was very insignificant. This accident, however, came near resulting seriously, for if the water had remained shut off for an hour longer in all probability the entire number of eggs then in the house would have been lost. Credit is due to the force at the Detroit station for the prompt and intelligent measures taken by them in this emergency and to the citizens living in the neighborhood for their efficient help in keeping the water in motion as far as it could be done by bucket brigade which undoubtedly saved the entire hatch from total loss.

The board has directed that a force pump or engine be procured for use should another emergency of this kind arise. Relief can then be had by forcing the water from the tanks through the jars. This may not be necessary, however, as the Detroit Water Board has taken steps to prevent a recurrence of this trouble.

As intimated above the Detroit hatchery has now added to its former capacity the jars heretofore carried at the Petoskey station which will give to the Detroit station a present capacity of 525 jars. This will furnish the Detroit station a capacity for hatching between eighty and ninety millions of whitefish the coming season.

The efficiency of the artificial propagation of whitefish has been so completely demonstrated by the reports from Lake Erie and other points, as shown in another part of this report, that it is urgently requested that the legislature shall at the coming session allow a sufficient amount in the estimates of this board for the coming two years to allow the present capacity of the house at Detroit to be doubled.

2.—*Paris Station.*

On February 8 and 9, 1887, the Fishery Committee of the House of Representatives visited the Paris station. It seems a little unfortunate that

the Legislative Committee can not see this station when it is in its summer dress: it looks so much better when the grass and trees are green and the well kept flower beds are in bloom. The committee, however, saw the old hatchery full almost to overflowing with brook trout eggs and young fry, and appreciated at once the necessity of a new and larger hatchery. At the time of their visit nearly every available inch of room in the troughs was filled; there were about 900,000 young trout then in the house. Every year some improvements have been added about the premises, and every effort is made by the superintendent, the overseer and the assistants to make and keep the ponds and premises as attractive as possible for visitors, of whom there are hundreds during the summer. The citizens in that locality, for many miles around, seem to appreciate the attention they receive, and take pride in bringing their visitors to the station to see the ponds of trout.

In June of this year an effective sign was laid on the sloping lawn south of the house, plainly visible from the highway and railway, reading "State Fish Ponds." The letters are made of cobble stones of medium size painted white, the letters being about six feet long.

The improvements between the railroad and the river were completed in the summer. The ground there along the old bed of the brook is laid out with three good sized wild ponds, four ponds with rip-rapped stone walls, and three plank spawning ponds with spawning races, like those above. The additional water supply, brought through the crock drain, gives a good supply of the finest water, and makes it possible to carry safely the large stock of trout now in the ponds. All the damage done by the freshet of September, 1886, has been fully repaired, and the station is in better order now than before. The large waste ditch around the upper ponds has proved of ample size to take care of as large a flow of water as can come down Cheney creek. This waste way has been paved with stone from the back of the old hatchery to its entrance into the large wild pond; and the walls of it laid up in stone. The waste from the new ponds east of the railway, is made by a crock underground and empties into the second wild pond from the river. On the Buckhorn creek a levee has been constructed from the dam at the head of the grayling wild pond around to the high bank on the west side of the pond, to protect it from freshets. The west ditch around the grayling pond has been enlarged and the dam across the main creek widened. The action of the water when high has dug a fine large pool just below this dam. This waste way is 20 feet wide on the bottom.

A public drinking fountain has been placed on the edge of the highway in front of the old hatchery. Here considerable grading has been done on the road on both sides of the creek, raising the road level about two feet, and a new bridge constructed across the creek, and an extension of the neat rail fence carried across the bridge, on each side, to completely guard the bridge, which is now 28 feet wide.

The ice and feed house as been enlarged by lengthening it six feet, and placing a good chimney and fireplace in it. A large amount of cleaning up has been done on the premises which has materially improved the appearance of the property.

The most important improvement made at Paris station is the new hatching house. It is a model in general appearance, in substantial and suitable interior finish, in convenience of arrangement and in its complete adaptation to the requirements of the station. The house is placed south of the large

wild pond fronting on the highway. It is 82½ feet in length north and south, gabled at each end, and 40 feet wide, having a small gable midway on the east side facing towards the railway; and a gabled projection on the west side fronting the highway, about eight feet wide inside, in which the stairway to the loft is carried up. In the loft are two good rooms, one at each end, which serve as bed-rooms; and the space between the rooms is an unfinished attic affording ample room for storage.

The main hatching room is perfectly lighted from windows on all sides, those at each end being high. This room is the full size of the house. It is ceiled on the walls and overhead and neatly painted. It is warmed in winter by one large stove, and has also a good sized open fireplace where fire is kept during hatching season. The open fire ventilates the room perfectly, and keeps the room dry, making it much more comfortable to work in. Water is introduced into the house from the creek above the ponds through a 12-inch pump log, the connection at the house being made through two iron pipes coming up on the outside of the house, on both sides of the front entrance, then through the sides, and is discharged into two large tanks. The water supply on each side is independent of the other; each having its own valve to regulate the flow of water. From the receiving tanks the water is taken in to the smaller feed-troughs which are placed just under the windows, going around the house to the east side entrance. The hatching troughs are supplied from the feed troughs through brass faucets, so that the supply is under perfect control. These troughs are one foot wide by fourteen feet long, placed in groups of three, with a narrow alley between the groups. The water is wasted from the troughs through tin overflows down through the floor into open drains paved and cemented. Passing through the several drains, which all flow into one outlet, the water comes through an opening in the foundation, which is of stone, on the east side of the house, and flows into the creek below the large wild pond. All of the arrangements of the house are as complete as our experience could suggest, and during the last season's work proved to be most satisfactory in every respect.

The house is of frame, battened on the outside, set on a stone foundation. It is substantially built and it is believed will compare favorably with the best of modern hatching-houses. The first drawings were made by the commissioner in charge, after many consultations with the Superintendent; they were then placed in the hands of Mr. A. B. Cram, architect, of Detroit, and by him elaborated and perfected and complete specifications drawn. The plans were examined and fully approved by the Fishery Committee of the Legislature.

As soon as the appropriation bill had passed the Senate, coming from the House, bids were invited from builders in that part of the State, that of Mr. John G. Mosser, of Cadillac, being accepted a contract was made with him, and the statutory bond taken. The contractor was very prompt, and all his work was excellently done. The work was well under way by July 1, and the water was turned on for the first time October 4. The interior work could not very well be done by contract, so the material was all purchased by the commission, and a good local carpenter, Mr. Judkin, of Paris, employed by the day, under the Superintendent's direction, to put it together. This work was begun in August, in the old hatchery and was ready to put in place as soon as the painters could give possession. The total cost of the house ready for the season's operations was $4,123.51

The contract part was, for the house, without excavation	$2,951
The excavation and grading	125
The interior furnishings, pump log laying and all water supply	1,047.51
	$4,123.51

The house is insured for $2,500, and other property in the house, $650.

The total expenditure for permanent improvements at the station, for the two years was:

For the house and fittings, as above	$4,123.51
For new ponds, grading and fencing	676.29
For repairs, necessitated by the freshet of 1886	401.46
	$5,201.26

The development of the work at Paris requires some further expenditure during the coming two years, to bring the station to its utmost capacity. By making a connection from the Buckhorn creek to the Cheney creek above the stock ponds, five new ponds can be added to the plant, which will enable us to carry all the stock fish that the water supply can support.

The successful transfer of the Little Buckhorn waters to Cheney creek two years ago, demonstrates that this use of the water is by far the most economical that can be made of it. It concentrates the work of all kinds, the cleaning of ponds, feeding and sorting of fish, the protection of the fish from depredation of all kinds, and the taking of eggs. Both of the Buckhorn creeks play an important part in the rearing of trout in the wild state, and that use of them is not materially impaired by transferring so much of the water as can be used to advantage in supplying additional ponds on Cheney creek. This connection will be made by a 12 inch pump log, the entire cost of which laid ready for use will be about $280.

The other improvements required at the station to put the property in as good order as all state property should be kept in, are as follows:

a. An 80 barrel tank, 16 foot platform, connections and piping about 800 feet	$ 280
b. Fencing for 80 acres of land and meander of the Cheney creek	300
c. Clearing land, cut or burned over, and to finish the required grading	100
d. Five new stock ponds in connection with the present pond system on Cheney creek, stone walls, races and plank spawning ponds	500
e. Additional trays to complete equipment of the new house, new cans and current repairs	150
f. Buckhorn connection, mentioned above	280
	$1,510

3.—Petoskey Station.

The importance of the whitefish work as the leading feature of what should be the future work of the state was early impressed upon the minds of those who were appointed by the Governor to see that the work should be carried forward and from that time until now has been the prominent work

of the commission. One of the chief obstacles at the outset was the difficulty of obtaining ova. At first the only way was to go to some fishing station and as the nets were drawn or emptied, the fish were handled, and the ova of such as were ripe taken and fertilized and conveyed to the hatching station. The spawning season, coming as it does at one of the most inclement seasons of the year, made this a difficult and often a dangerous task. When later on, through experiments instituted by this commission, it was found to be thoroughly practicable to take the whitefish and hold them in captivity until such a time as the female fish should mature and the ova be obtained with comparative ease, and without necessitating the death of the fish, the whole plan of obtaining an adequate supply of eggs was necessarily changed. The purchase and equipment of a car expressly adapted to the work of the commission has added another factor to a change in the first thought of the commission. At the time of establishing the Petoskey station the question of obtaining ova and that of transportation were the paramount ones and it was thought that the work could be better carried on by having several stations situated near to those points where fish were caught in the largest quantities, and where the young fish when hatched could be the most advantageously planted. Consequently some place on the eastern shore of Lake Michigan, where a station could be located, seemed almost imperative. After a careful survey of different localities, the one at Petoskey seemed to offer the greatest facilities for successful work, the important question of a water supply was settled by the citizens of Petoskey generously granting to the commission the use of water from their city system, free of charge. It had been stated to the commission and believe by them, that the water from the well from whence the supply was drawn, was the water from the bay that found its way into the well by percolation through the comparatively small space between the well and the adjacent shore line, and consequently would be all that could be desired; but subsequent experiments proved this to be a mistake, as the water was found to have a temperature so much higher than the lake, one or two degrees, constantly, as to hasten the hatching of the eggs, so much as to bring them out from four to five weeks in advance of those at Detroit, and the planting had to be done in many cases through the ice. This was at first thought to be a fatal objection, but subsequent experiments seemed to prove that it might be otherwise. Within the last year it became apparent that the capacity of the house at Detroit could be so enlarged, at a small expense, as to receive all the jars in use at Petoskey and consequently all the expense of the equipping and maintaining of the Petoskey station could be saved; for but little extra expense would be incurred by the new arrangement. So in October the jars were brought to Detroit, and are now in successful operation. The possibility of again opening the Petoskey house is as yet an open question, to be more definitely settled by the experiments of this season.

4.—Glenwood Station.

A full description of Glenwood station was given in the last biennial report. To the station as then described has been added a house constructed in such a manner as to furnish conveniences for preparing the young fish for shipment as well as to provide a storehouse for the tools, apparatus and cans and winter quarters for the fish. The house is a frame building 18x24 feet in size,

substantially built upon a basement or cellar the same size as the house, and constructed around the main spring, from which it is constantly supplied with fresh water. The walls of this basement are laid in cement to keep out all enemies of the carp. It is divided into compartments for the different sizes of fish, and being supplied with living water from the spring furnishes admirable winter quarters. The temperature of the water during the winter is very uniform, averaging about 50 degrees. One hundred and sixty breeding carp, weighing from two to fifteen pounds, were carried in this spring house during the winter of 1887–8 without loss, and five thousand small fish in addition to these can be safely cared for during the winter if properly separated, according to size, in the compartments.

A large number of carp were hatched during the last season and many more could have been distributed if orders and shipping directions had been received. The superintendent experiences much difficulty in getting correct shipping directions and many orders have been canceled for want of them.

There is an impression among the people that it is difficult to get carp for their ponds. This is an erroneous idea, and it is the desire of this commission to correct it. The fish may be had upon proper application and no difficulty will be experienced in getting them if the persons who have made suitable application will, upon being notified by the overseer, send to him full directions for shipping and assure him that some person will be ready to receive the fish when they arrive at their destination; the only expense being the express charges on the fish and the return of the can in which they are sent.

The station is in good condition and well supplied with young fish that will be ready for shipment as early in the spring as they are taken from their winter quarters.

The commission hasa pamphlet containing valuable information in regard to the culture of carp which will be gladly sent to all who may apply for it.

V. EXAMINATION OF INLAND LAKES.

1. WORK OF 1887.

This department of the commission's work has improved in quality and facility as experience has gradually pointed to improved methods. The knowledge gained in the work of earlier years has made the work much more expeditious and exact. It has been found that certain conditions or characteristics are constant. So that by ascertaining essential characteristics of a given lake, say in the same water-shed with other lakes already examined, we can predict with practical certainty its present inhabitants, and the kinds of fish for which it is suited by the food supply. The most important factors are depth, temperature and food, with general quality of water and bottom. These are readily ascertained, and within reasonable limits enable us to judge of the capacity of the given water. Size is also a consideration, but is a question rather of degree than of kind. For instance, an examining crew go quite into a county in the second or third tier of the state, counting from the southern boundary, in the four northeastern townships the general characteristics of the country are the same. There are, say, seven lakes of fair size from three-quarters of a mile to three miles in length, varying in width from one-half to one and one-half miles. Two of these lakes are examined carefully, gill-nets set three nights, soundings

made, temperature of water taken at surface and bottom each morning and evening, the bottom dredged, the stomachs of all fish examined and contents observed, search made for the quantities of food similar to that found in the captured fish, the condition of the fish carefully observed, the similarity of the lakes and their fauna noted. All then that is necessary to learn about the other five lakes is the substantial correspondence in the essential particulars above mentioned, and we know what is to be found in the other five, and whether any but the native kinds of fish can be grown in them to advantage. If in taking the depth and temperature of the five lakes any one of them exhibits a marked contrast to the first two in any essential particular, that lake must be further examined. If there is substantial agreement in the conditions named, all that need be learned about the five lakes, with the depth and temperature ascertained, can be learned from the report on the two first examined.

In 1887 eighty lakes were examined and reported on. There is following this article a condensed statement of the reports, sufficiently full for most purposes. The reports are bound together in books of convenient size, indexed, and constitute a permanent record of great interest, which will serve as the basis for all future operations on the waters so examined. They enable Commissioners and Superintendent to answer all inquiries as to what can or will be done for the examined lakes which frequently come from persons living near or interested in any particular lake, and furnish information so exact and comprehensive as to make the answers conclusive, as well as satisfactory to the inquirers.

Of the 80 lakes reported on in the season of 1887 only five contained the genuine black bass, the small-mouthed bass, as usually denominated, while probably 20 or more of these lakes are well adapted to them. And about 18 appear to have the depth, temperature, food and bottom suitable to the growth of the brook trout. Whitefish were found in five lakes, herring in 13, and 16 of them are probably suitable for salmon trout.

EXAMINATION OF INLAND LAKES, 1887.

Berrien County.

Allen, or Long, Lake, Berrien Township—*Crew No. 1:*
Length, ½ mile; width, ¼ mile; greatest depth, 32 feet.
Shores, sandy on east and west, with high sandy banks and woods north and south; flat, marshy banks.
Bottom, soft, black mud.
Inlets, none; outlets, one during high water, emptying into Smith's Lake.
Dates of examination, September 28 and 29.
Weather, clear.
Temperature—Surface, 61° and 62°; bottom, 49°.
Water, clear.
Fish are perch, blue-gills, sunfish, shiners and chubbs. Fish small but fat.

Big Paw Paw Lake, Watervliet Township—*Crew No. 1:*
Length, 3 miles; width, 1 mile; greatest depth, 100 feet.
Shores, sandy and gravel; banks high except 3 miles on north shore, low, marshy and wooded nearly around lake.
Bottom, mostly hard sand, in deepest waters soft, covered with black sand.

Inlets, two, outlet of Little Paw Paw Lake, and Paw Paw river; outlets, one, Paw Paw river.
Date of examination, September 23, 24 and 25.
Weather, 23, clear; 24, cloudy; 25, clear.
Temperature—Surface, 63°; bottom, 47, 47, 49°.
Water, clear.
Fish are perch, blue-gills, grass pike, large mouth bass, straw bass, suckers, bull-heads, chubbs and German pike. Fish well fed, but small.

Clear Lake, Buchanan Township—*Crew No. 1:*
Length, 3 miles; width, 1 mile; greatest depth, 63 feet.
Shores, sandy on east and west; north and south flat and marshy.
Bottom, sandy near shore, soft and muddy in deep water.
Inlets, none except in high water, and no outlet except in high water.
Dates of examination, October 2 and 3.
Weather, 2, clear; 3, cloudy.
Temperature—Surface, 60°; bottom, 45°.
Fish are perch and blue-gills, large and fat. It is said there are plenty of small-mouth bass in this lake.

Hess Lake, Lake Township—*Crew No. 1:*
Date of examination, Oct. 1.
This lake is nearly covered with weeds, etc.

Little Indian Lake, Berrien Township—*Crew No. 1.*
Length ½ mile; width ¼ mile; geatest depth, 12 feet.
Shore, sandy.
Bottom, hard.
Inlets none; outlets none.
Date of examination. Oct. 1.
Temperature—Surface and bottom, 60°.
Water, clear.
Fish are said to be bass and blue-gills, none caught.

Long, Reggins, Webster, and Murphy's Lakes, Berrien Township—*Crew No. 1:*
Date of examination, Oct. 1.
All of these lakes are drained, so there is little left of them, and they are covered with pond lilies and weeds.

Meadow, Yellow, Weaver, and Pike Lakes in Berrien and Bertrand Townships—*Crew No. 1:*
Date of examination, Oct. 3.
These lakes have all been drained, so there is very little left of them. The bottoms are muddy, and they contain very few native fish.

Pipestone Lake, Bainbridge Township—*Crew No. 1:*
Length, 1 mile; width, ¼ mile; greatest depth, 36 feet.
Shores, soft and marshy, low flat banks.
Bottom, soft and muddy, covered with weeds.
Inlet, one small spring creek on north side; outlet, one large outlet on southwest side.

Dates of examination, September 20, 21 and 22.
Weather, 20 clear, 21 and 22 rainy.
Temperature—Surface, 67, 66 and 64°; bottom, 50, 49 and 49°.
Water, clear.
Fish, perch, blue-gills, sunfish, bull-heads, suckers and rock bass. Fish well fed, but small.

Smith Lake, Berrien Township—*Crew No. 1:*
Length, 1 mile; width half mile; greatest depth, 86 feet.
Shores, sandy on east and west, north and south muddy; bottom soft and muddy, covered with grass and weeds.
Inlets, one during high water only; outlet, one small stream emptying into Dowagiac Creek.
Date of examination, September 26, 27 and 28.
Weather, 26, rainy; 27, rainy; 28, clear.
Temperature—Surface, 63, 62 and 62°; bottom, 49, 50 and 50°.
Water, clear.
Fish, perch, blue-gills, sunfish, rock bass, shiners, dogfish and suckers. Fish were fat but small growth.

Lake View, Berrien Township.—*Crew No. 1:*
Length, 60 rods; width, 40 rods; greatest depth, 35 feet.
Shores, flat and marshy; bottom, soft mud.
No inlets or outlets.
Date of examination, Sept 28.
Temperature—Surface, 62°; bottom, 43°.
Water, clear.
Fish, black bass, perch and blue-gills.

No name, Berrien Township—*Crew No. 1:*
Length, 60 rods; width, 40 rods; greatest depth, 30 feet.
Shores, soft and marshy; bottom, soft, black mud.
No inlets or outlets. Nice springs on the shore.
Date of examination, Sept. 29.
Temperature—Surface, 61°; bottom, 43.
Water, clear.
Fish, bass, blue-gills, perch and bull-heads.

Cass County.

Bear Lake, Porter Township—*Crew No. 1:*
Length, 1 mile; width, ½ mile; greatest depth, 13 feet.
Shores sand and gravel. High banks all around the lake, wooded on south and east.
Bottom, soft and grassy.
No inlet or outlet.
Dates of examination, August 20 and 21.
Temperature, surface 74 and 73°; bottom 60 and 59°.
Water, clear.
Fish, large-mouth bass, perch and blue-gills; the fish taken were hard and well fed, blue-gills were very large.

Baldwin's Lake, Porter Township—*Crew No. 1:*
Length, 1½ miles ; width, 100 rods; greatest depth, 57 feet.
Shores, sandy and gravel; high banks all around lake.
Bottom, hard gravel.
Inlets, two; one small spring in north end, and the outlet of Indian Lake on south end; outlet, one small channel running to Long Lake.
Dates of examination, Sept. 7 and 8.
Weather, clear.
Temperature, surface, 73 and 71° ; bottom, 48°.
Water, clear.
Fish, herring, grass pike and perch; fish hard and well fed, herring showed large growth.

Barron Lake, Howard Township—*Crew No. 1:*
Length, 1 mile; width, ½ mile; greatest depth, 28 feet.
Shores, hard, sand and gravel, with high sandy banks, timber in small groves on the shore.
Bottom, greater part sand and gravel, some places mud.
Inlets, none; outlets, one, a 10 inch pipe which supplies the city of Niles.
Dates of examination, Oct. 4, 5, 6 and 7.
Weather, 4 and 5, cold and cloudy; 6, cloudy; 7, clear.
Temperature, surface, 58, 58, 59 and 59°; bottom, 52, 51, 52 and 51°.
Water, clear.
Fish, perch, sunfish, blue-gills, rock bass, large-mouth bass, and suckers; fish hard and very fat, but small growth, except suckers which are large.

Birch Lake, Porter Township—*Crew No. 1:*
Length, 1½ mile; width, ¾ mile ; greatest depth, 107 feet.
Shores, hard, sandy, with high banks.
Bottom, hard sand.
Inlet, none; outlet, one, small stream emptying into Shavehead Lake.
Dates of examination, Aug. 22, 23, 24 and 25.
Weather, 22, cloudy; 23, raining; 23 and 24, clear.
Temperature, surface, 22, 74; 23, 70; 24, 71; 25, 70°; bottom, 22, 43; 23, 43; 24, 43; 25, 43°.
Water, clear.
Fish, herring, hard and well fed, of large growth.

Cable Lake, Silver Creek Township—*Crew No. 1:*
Length, ½ mile; width, ¼ mile; greatest depth, 42 feet.
Shores, sand and gravel, high sandy banks, wooded.
Bottom, soft.
Inlets, none; outlets, none.
Date of examination, September 20.
Temperature—Surface, 60° ; bottom, 49°.
Fish, blue-gills, perch, bass and shiners.

Chain Lake, Calvin Township—*Crew No. 1:*
Greatest depth, 23 feet.
Inlets, none; outlet, empties into Christian Lake.
Date of examination, September 8.
Temperature—Surface, 73° ; bottom, 65°.

Water, clear.
A chain of lakes all connected, none over 60 rods long and about 40 rods wide. They extend down through a marsh and include Chain, Long, Thorpe's, Calkins and Curtis lakes.

Christian Lake, Ontwa Township—*Crew No. 1:*
Length, ¾ mile; width, ½ mile; greatest depth, 37 feet.
Shores, hard sand all along south shore; north shore marshy; east and west, low banks and marshy.
Bottom, hard on east, soft on west side.
Inlets, large channel running out of Juno Lake; outlets, one large stream called Christian creek.
Dates of examination, September 3 and 4.
Weather, clear.
Temperature—Surface, 3, 71°; 4, 70°; bottom, 3, 52°; 4, 52°.
Weather, clear.
Fish, strawberry bass. Fish in good condition, hard and fat.

Dewey's Lake, Silver Creek Township—*Crew No. 1:*
Length, 1¼ miles; width, ¾ mile; greatest depth, 56 feet.
Shores, sand and gravel; high sandy banks, woods extending nearly around the lake.
Bottom, hard, sandy, except through center; in deep water black, muddy bottom.
Inlets, none; outlets, none.
Dates of examination, September 12 and 13.
Weather, September 12, cloudy and cold; 13, clear and cold.
Temperature—surface, 12, 64°; 13, 65°; bottom, 12, 48°; 13, 49°.
Water, 13, clear; 14, muddy.
Fish, large-mouth bass, perch, blue gills, bullheads and shiners.
Fish, large growth and fat, except perch were small.

Diamond Lake, Penn and Jefferson Townships—*Crew No. 1:*
Length, 3¼ miles; width, 2 miles; greatest depth, 62 feet.
Shores, gravel and sandy, high banks all around lake.
Bottom, sand and gravel.
Inlets, none; outlets, one small stream.
Dates of examination, August 27, 28, 29 and 30.
Weather, clear.
Temperature—surface, 70°; bottom, 46°.
Water, clear.
Fish, wall-eyed pike, small-mouth bass, large mouth bass, perch, rock bass, blue-gills, grass pike. Fish hard, well fed and large growth.

Donell Lake, Penn Township:
Length 1¼ miles; width, ¼ mile; greatest depth, 62 feet.
Shores, soft and grassy; flat banks and marshy.
Inlets, one small one; outlets, one small stream running to Mud Lake.
Dates of examination, August 26 and 27.
Weather, clear.
Temperature—surface, 70°; bottom, 48°.

Water, clear.
Fish, herring, small-mouth bass and perch. Fish taken are hard and well fed. Herring show large growth.

Driskel Lake, Newberry Township:
Length, 100 rods; width, 80 rods; greatest depth, 34 feet.
Shores, sandy.
Bottom, soft on west end; east end hard, sandy.
Inlet, none; outlet, none.
Dates of examination, August 19 and 20.
Weather, clear.
Temperature, surface, 19, 74°; 20, 73°; temperature, bottom, 57°.
Water, clear.
Fish, blue gills.
Fish taken seem to be well fed and of large growth.

Eagle Lake, Ontwa Township:
Length, 1½ miles; width, ½ mile; greatest depth, 30 feet.
Shores, hard, sandy, except about 60 rods on west shore; high banks and wood nearly around lake.
Inlets, none; outlets, one small stream running into Indian Lake.
Dates of temperature, Sept. 6 and 7.
Weather, 6, cloudy; 7, clear.
Temperature, surface, 6, 72°; 7, 70°; bottom, 60°.
Water, clear.
Fish, blue-gills, grass pike, strawberry bass, perch and rock bass.
Fish fat and show large growth.

Fish Lake, Newberry Township:
Length, ¾ mile; width ¼ mile; greatest depth, 37 feet.
Shores, high banks all around.
Bottom, soft on west side; hard on east.
Inlets, none; outlets, none.
Date of examination August 23.
Temperature—surface, 74°; bottom, 50°.
Water, clear.
Black bass in large quantities, plenty of blue-gills and perch. The bass very large.

Forked Lake, Newberry Township:
Length, 100 rods; width, 80 rods; greatest depth, 12 feet.
Bottom, soft and muddy, lilies covering the most of the surface.
Date of examination, August 24.
Temperature—surface, 74°; bottom, 50°.
Large quantities of black bass.

Goff Lake, Marcellus Township:
Length, 80 rods; width, 60 rods; greatest depth, 40 feet.
Shores, flat and marshy; bottom, soft and muddy.
Inlets, none; outlets, none.
Date of examination, August 25.

Temperature—surface, 74°; bottom, 50°.
Fish blue-gills, perch and bull-head.

Goose Lake, Jefferson Township—*Crew No. 1:*
Length, about 60 rods; width, about 40 rods; greatest depth, 16 feet.
This lake has been drained to its present size.

Hemlock Lake, Marcellus Township:
Length, ½ mile; width, ¼ mile.
Shores, marshy on north side and high banks on south, east and west.
Bottom, hard.
Inlets, none; outlets, none.
Date of examination, August 23.
Temperature—Surface, 74°; bottom, 52°.
Water, clear.
Fish, bass, blue-gills and perch.

Indian Lake, Silver Creek Township:
Length, 1¼ miles; width, ¾ mile; greatest depth, 28 feet.
Shores, sand and gravel, high sandy banks and woods on north and east.
Bottom, sandy some distance from shore, but through center is muddy and covered with moss and weeds.
Inlets, one small stream on north end. Sandy bottom; water clear and cold. Outlets, one small outlet near south side during high water only.
Dates of examination, September 17, 18 and 19.
Weather, clear.
Temperature—Surface, 17 and 18, 64°; 19, 68°; bottom, 17, 60°; 18, 61°; 19, 62°.
Water, clear.
Fish, blue-gills, perch, straw bass, sunfish, suckers, bull-heads and shiners. The fish taken are hard, well fed and show very large growth, except perch, which are small.

Juno Lake, Mason and Calvin Townships:
Length, ¾ mile; width, 1 mile; greatest depth, 38 feet.
Shores are soft and muddy.
Bottom, soft and grassy in east end, near inlet and west end; hard on north side.
Inlets, two; one small stream emptying in on east end, one large channel coming in on the north side; outlet, one long channel emptying into Christian Lake.
Dates of examination, September 4, 5 and 6.
Weather, 4 and 5, clear; 6, cloudy.
Temperature—Surface, 4, 72°; 5, 70°; 6, 71°; bottom, 52°.
Water, clear.
Fish, blue-gills, rock bass and bull-heads. The fish taken are hard and well fed; blue-gills large and fat.

Lily Lake, Newberry Township:
Length, ¼ mile; width, 50 rods; greatest depth, 24 feet.
Shores, muddy, low banks.

Bottom, muddy,
Inlets, none; outlets, one small stream running into Hutchinson Pond.
Date of examination, August 23.
Temperature—surface, 74°; bottom, 62°.

Mulford Lake, Volnice Township:
Length, 75 rods; width, 20 rods; greatest depth, 12 feet.
Shores, flat, marshy banks.
Bottom, soft mud.
Date of examination, August 23.
Temperature—surface, 73°; bottom, 64°.

Long Lake, Porter Township:
Length, 1¾ miles; width, ¼ mile; greatest depth, 36 feet.
Shores, sand and gravel, except about 60 rods on east shore and 70 rods on west shore.
Bottom, hard, with rushes around the edge of water.
Inlets, two; one a small stream the outlet of Birch and Shavehead Lakes and one a small stream the outlet of Robbins Lake; outlets, one quite large stream, running down in the Indian Lake.
Dates of examination, September 7 and 8.
Weather, clear.
Temperature—surface, 7, 72°; 8, 70°; bottom, 51°.
Fish, herring, whitefish, perch, blue-gills and black suckers. The fish taken are well fed; herring show large growth; the white fish weighed 3 pounds.

Cass and Van Buren Counties.

Margican Lake, Silver Creek and Keeler Townships:
Length, 2½ miles; width, ¾ mile; greatest depth, 48 feet.
Shores, sand and gravel on north, south and east; west marl; high sandy banks, except on west; shores low, low banks; timber extending nearly around the lake.
Bottom, sandy around the islands and near shore; through the center is marl bottom.
Inlets, none; outlets, none.
Dates of examination, September 13 and 14.
Weather, clear.
Temperature—surface, 13, 66°; 14, 67°; bottom, 49°.
Water, clear.
Fish, blue-gills, perch, rock bass and bullheads. The fish taken were hard, well fed and show large growth.

Cass County.

Mud Lake, Calvin Township:
Length, 1 mile; width, 100 rods; greatest depth, 57 feet.
Shores are marshy all around, east, south and north; west end high banks and sand.
Bottom, hard.

Inlets, one, from Donell's Lake; outlet, asmall s tream running into some small streams in southern part of township.
Dates of examination, August 28 and 29.
Weather, clear.
Temperature, surface, 28, 70°; 29, 69°; bottom, 46°.
Water, clear.
Fish, herring, grass pike and perch.
Fish taken were in good condition and show very large growth.

Painter Lake, Calvin and Jefferson Townships:
Length, ½ mile; width, ¼ mile; greatest depth, 36 feet.
Shores, soft marshy shores extend all around the lake.
Bottom, soft and grassy.
Inlets, one large stream called Christian creek; outlets, one large stream emptying into Juno lake.
Dates of examination, September 5 and 6.
Weather, 5, clear; 6, cloudy.
Temperature, surface, 70°; bottom, 51°.
Water, clear.
Fish, blue-gills and suckers.
Fish taken were hard and well fed; blue-gills show large growth.

Pleasant Lake, Ontwa Township:
Length, 100 rods; width, 80 rods; greatest depth, 20 feet.
Shores, hard and sandy, high banks; bottom, soft and grassy.
Inlets or outlets, none.
Date of examination, September 6.
Temperature—Surface, 73°; bottom, 70°.
Water, clear.
Fish, bass, blue-gills and perch.

Portage Lake:
Length, 1 mile; width, ½ mile; greatest depth, 34 feet.
Shores, flat and marshy; bottom, soft and grassy.
Inlets, Portage and Bear rivers; outlet, Portage river.
Date of examination, August 15.
Temperature—Surface, 78°; bottom, 52°.
The surface is nearly covered with weeds.

Sister Lake, Silver Creek Township:
Length, 1 mile; width, ½ mile; greatest depth, 58 feet.
Shores, sandy and gravel, high sandy banks, woods extending around the greater part of the lake; bottom, near shore is sandy; through middle of lake is soft and muddy.
Inlet or outlet, none.
Dates of examination, September, 14, 15 and 16.
Weather, clear.
Temperature—Surface, 14, 65°; 15, 66°; 16, 68°; bottom, 14, 48°; 15, 49°; 16, 50°.
Water, clear.
Fish, perch and blue-gills. Fish taken were hard, well fed and show large growth.

Shavehead Lake, Porter Township:
Length, 1¼ miles; width, ¼ mile; greatest depth, 69 feet.
Shores, hard, low banks, wooded on east and north; bottom, soft.
Inlets, one small stream coming from Birch lake; outlets, one small stream running to Long lake.
Dates of examination, August 24 and 25.
Weather, clear.
Temperature—Surface, 70°; bottom, 42°.
Water, clear.
Fish, herring. The herring are hard, well fed and very large growth.

Twin Lake, east, Wayne Township:
Length, 1¼ miles; width, ¼ mile; greatest depth, 48 feet.
Shores, sandy on east side, marsh on south side, gravel on north, high banks all around; bottom, soft mud in center and east end, gravel and sand, very bold shores.
Inlets and outlets none; a small isthmus and the lakes are connected by a small overflow in spring and fall.
Dates of examination, September 18 and 19.
Weather, clear.
Temperature—Surface, 18, 72°; 19, 73°; bottom, 49°.
Water, clear.
Fish, perch, large-mouthed bass, blue-gills and sunfish. Fish small, but well fed and in great numbers.

Skyhawk Lake, Newberry and Marcellus Townships:
Length, 100 rods; width, 80 rods; greatest depth, 47 feet.
Shores, sandy with low banks.
Bottom, sandy, hard.
Inlets, two small spring brooks; outlets, one small stream.
Date of examination, August 24.
Temperature, surface, 71°; bottom, 47°.
Water, clear.
Said to contain grass pike, strawberry bass.

Miller Lake, Marcellus Township:
Length, 80 rods; width, 60 rods; greatest depth, 23 feet.
Shores high on north, east and west; low on south side.
Bottom, soft.
Inlets, none; outlets, none.
Date of examination, August 25.
Said to contain black bass, perch, etc.

Cheboygan County.

Mullet Lake, Burt and Grant Townships:
Length, 12 miles; width 2 to 3 miles; greatest depth, 180 feet.
Shores, sand and stone, with high banks, with the exception of the lowe end.
Bottom, south end on middle ground stone; north end mud, clay and gravel.

Inlets, Pigeon and Indian rivers and Burt creek; outlets, Cheboygan river.
Dates of examination, Oct. 9, 10, 11, 12, 13, 14, 15 and 16.
Weather, 9, 11 and 12 rainy; 10, 13, 14, 15 and 16 clear.
Temperature, surface, 9, 11, 12, 52°; 10 and 13, 54°; temperature, bottom, 9, 13, 46°; 10, 47°; 11, 44°; 12, 44°.
Water, clear.
Fish, white fish, herring, perch, wall-eyed pike, grass pike, suckers, and lawyers.
Fish taken were fat and in good shape.

Burt Lake, Burt and Tuscarora Townships:
Length, 9 miles; width 5 miles; greatest depth, 50 feet.
Shores, sand and gravel.
Bottom, sand, clay, mud.
Inlets, Crooked river, Maple river and Sturgeon river.
Outlet, Indian river.
Dates of examination October 18, 19, 20, 21, 22, 23 and 24.
Weather—October 18 and 19, clear; 20, rainy; 21, 22, 23, 24, stormy.
Temperature, surface, 18, 60°; 19, 57°; 20, 53°; 21, 50°; 22, 48°; 23, 48°; 24, 47°; temperature, bottom, 18, 59°; 19, 46°; 20, 42°; 21, 39°; 22, 38°; 23, 38°; 24, 38°.
Water, clear.
Fish, grass pike, perch, rock bass, suckers and wall-eyed pike.
Fish taken were fat and in good order.

Clare County.

Town Line Lake:
Length, ½ mile; width, ¼ mile; greatest depth, 57 feet.
Shores are low and swampy, covered with a thick growth of tamarack, cedar and white birch, all but 20 rods on east side, where bank is high and cleared.
Bottom is mostly black muck, but in south end there is gravel bottom.
Inlets, one coming in on north side, a small spring brook about 200 rods long, very rapid, temperature 46°.
Outlet, one on the south side which is 6 feet wide and 10 inches deep, flowing south into a small lake.
Dates of examination, September 27, 28, 29 and 30.
Weather—September 27, 28, fair; 29, smoky; 30, rainy.
Temperature—surface, 27, 62°; 28, 63°; 29, 60°; 30, 58°; bottom, 27, 29, 30, 42°; 28, 40°.
Water, clear.
Fish, large-mouth bass have been taken which weighed 6½ pounds, and perch; fish fat and well fed.

Roscommon and Crawford Counties.

Higgins Lake, Gerrish, Roscommon County, and Beaver Creek, Crawford County:
Length, 7 miles; width, from 1 to 2½ miles; greatest depth, 95 feet.
Shores are mostly sand, with gravel and stone in places.

Bottom is nearly all sand, with patches of stone, gravel and marl, with very little mud.
Inlets, two small streams, which dry up in summer, and three or four boiling springs; outlets, one at south end of lake, which flows south into Houghton Lake.
Dates of examination, October 1, 2, 3, 4, 5, 6 and 7.
Weather, rainy, showery, and strong wind.
Temperature—surface, 57°; bottom, 48°.
Water, 1, 2, 3, 4, clear; 5, cloudy.
Fish, wall-eyed pike, perch, grass pike, whitefish, herring and black suckers. Fish are plump and well fed.

St. Joseph County.

Aldrich Lake, White Pigeon Township:
Length, ¾ mile; width, ½ mile; greatest depth, 35 feet.
Shores, high banks and wooded, except on north it is marshy.
Bottom, hard, sandy.
Inlets, none; outlets, one small stream emptying into Pickerel Lake, thence into Fawn River.
Dates of examination, August 5 and 6.
Weather, clear.
Temperature—surface, 78°; bottom, 58°.
Water, clear.
Fish, small-mouth bass, grass pike, blue-gills and gar-fish. Fish taken in good condition, well fed, and pike show large growth.

Beaver Lake, Colon Township:
Length, ½ mile; width, ¼ mile; greatest depth, 18 feet.
Shores, high banks on east and north, west and south low banks and marshy.
Bottom, soft and grassy; pond lilies extend 40 rods into lake on south shore.
Inlets, none; outlets, none.
Dates of examination, July 27 and 28.
Weather, clear.
Temperature—surface, 27, 82°; 28, 81°; bottom, 78°.
Water, muddy.
Fish, strawberry bass, blue-gills, suckers, bullheads and dog-fish. Fish taken are poor and of small growth.

Carp Ponds Lakes, Fabius Township:
Length, No. 1, 40 rods; No. 2, 30 rods; width, No. 1, 25 rods; No. 2, 26 rods; greatest depth, 10 feet.
Shores, mud.
Bottom, bad.
Inlets, none.
Outlets, none.
Date of examination, Aug. 18.
Weather, clear.
Temperature, surface, 85°; bottom, 69°.

Water, clear.
Fish, none.

Chapin Lake, Sherman Township:
Length, ½ mile; width, ¼ mile; greatest depth, 22 feet.
Shores, high banks extend nearly around the lake; low banks and marshy on south shore.
Bottom, soft and grassy except along north shore which is sand and gravel.
Inlets, none.
Outlets, a small stream running into Hog Creek.
Dates of examination, July 25 and 26.
Weather, clear.
Temperature, surface, 25, 80°; 26, 78°; bottom, 73°.
Water, clear.
Fish, large-mouth bass, blue-gills, strawberry bass, bullheads and shiners.
Fish taken were in good condition.

Clear Lake, Fabius Township:
Length, 1½ miles; width, ½ mile; greatest depth, 41 feet.
Shores, hard, sandy, with high banks all around lake.
Bottom, hard.
Inlets, none; outlets, none.
Dates of examination, August 12 and 13.
Weather, clear.
Temperature—Surface, 12, 78°; 13, 76°; bottom, 51°.
Water, clear.
Fish, perch, blue-gills, small-mouth bass, suckers and bull-heads. Fish taken were fat and showed large growth.

Corey's Lake, Fabius Township:
Length, 1½ miles; width, 1¼ miles; greatest depth, 79 feet.
Shores, sand and gravel; high banks extend all around the lake, wooded on the east and south.
Bottom, hard gravel and sand; rocky in the west end.
Inlets, none; outlets none.
Dates of examination, August 10 and 11.
Temperature—Surface, 10, 77°; 11, 78°; bottom, 46°.
Water, clear.
Fish, herring, blue-gills, suckers, perch and large-mouth bass. Fish taken are harder than any we have found before; the herring show large growth.

Crotch Lake, Sherman Township:
Length, ¾ mile; width, ½ mile; greatest depth, 41 feet.
Shores, on north and south marshy; on east some high banks and sandy; west, high banks.
Bottom, north, south and center soft; some places on east and west hard and sandy.
Dates of examination, July 19, 20 and 21.
Weather, 19, 20, clear; 21, cloudy.

Temperature—Surface, 82°; bottom, 58°.
Condition of water, clear.
Fish, blue-gills, pickerel, suckers, bass, bull-heads and strawberry bass. Fish hard and well fed; great growth of young bass.

Crossman Lake, Sherman Township:
Length, 100 rods; width, 8 rods; greatest depth, 50 feet.
Shores, low banks, marshy all around lake.
Bottom, muddy, except a short distance on east side the water is shallow and sandy bottom.
Dates of examination, July 20, 21 and 22.
Weather, clear.
Temperature—surface, 84°; bottom, 54°.
Fish, blue-gills, suckers, strawberry bass and rock bass. Fish are well fed but small, except suckers, which are very large.

Fish Lake, Sherman Township:
Length, ¾ mile; width, ½ mile; greatest depth, 106 feet.
Shores, gravel and sandy, high banks all around lake.
Inlets, none; outlets, none.
Dates of examination, August 2 and 3.
Weather, clear.
Temperature—surface, 82°; bottom, 46°.
Water, clear.
Fish, perch, blue-gills, bullheads and shiners. Fish taken were well fed; perch extra large growth; blue-gills small growth.

Fish Lake, Burr Oak Township:
Length, ½ mile; width, 100 rods; greatest depth, 36 feet.
Shores, low banks, marsh extending nearly around the lake, except about 20 rods on north shore.
Bottom, hard and sandy, except in south end of lake.
Inlets, a small stream running out of Cross lake; outlet, a small stream emptying into Hog Creek lake, then in Prairie river to St. Joseph river.
Dates of examination, July 22 and 23.
Temperature—surface, 22, 81°; 23, 78°; bottom, 22, 47°; 23, 46°.
Water, clear.
Fish, blue-gills, whitefish, herring and bill-fish. Fish, herring soft, whitefish and blue-gills hard and in good condition.

Fisher's Lake, Park Township:
Length, 1 mile; width, ½ mile; greatest depth, 46 feet.
Shores, high banks and sandy shores.
Bottom, on north-east end hard, sandy bottom; south and west muddy.
Inlets, none; outlets, one little stream running down through a big marsh.
Dates of examination, August 13 and 14.
Weather—August 13, clear; 14, rainy.
Temperature—Surface, 76°; bottom, 54°.
Water, clear.
Fish, blue-gills, perch and grass pike. Fish well fed, but of small growth.

Hog Creek Lake, Burr Oak Township:
Length, 1 mile; width, ½ mile; greatest depth, 56 feet.
Shores, marsh extends northeast around to south shore, on the east are high banks wooded about half around shore.
Bottom, northern portion hard and sandy, southern part soft and grassy.
Inlet, Hog creek; outlet, Hog creek. It is quite a large stream, running into Prairie river, thence to St. Joseph.
Dates of examination, July 23, 24, 25 and 26.
Weather, clear.
Temperature—Surface, 23, 24 and 26, 78°; 25, 79°; bottom, 46°.
Water, clear.
Fish, suckers. There has been plenty of fish here, but constant fishing has taken them nearly all out.

Johnson's Lake, Sherman Township:
Length, ¾ mile; width, ¼ mile; greatest depth, 36 feet.
Shores, on east, stony; west, pond lilies; north and south marshy.
Bottom, muddy, except a little on east end, which is hard and stony.
Inlets, none; outlets, none.
Dates of examination, July 18 and 19.
Weather, clear and warm.
Temperature—Surface, 80°; bottom, 66°.
Water, clear.
Fish taken, 7 bass with minnows and four blue-gills with worms.
Condition, plenty of large-mouthed bass; all seemed to be about two years old.

Koser's Lake, Fabius Township:
Length, ¾ mile; width, ¼ mile; greatest depth, 18 feet.
Shores, sandy and gravel; high banks extend all around the lake, wooded on east and west.
Bottom, hard and sandy.
Inlets, none; outlets, none.
Dates of examination, August 9 and 10.
Weather, clear.
Temperature—Surface, 9, 80°; 10, 78°; bottom, 68°.
Water, clear.
Fish, large-mouth bass, blue-gills and perch. The fish were in good condition, but not very large.

Klinger Lake, White Pigeon Township:
Lenth, 2½ miles; width, 1 mile; greatest depth, 85 feet.
Shores, hard and sandy extending all around the lake; the banks are high and wooded nearly around the lake.
Bottom, hard and sandy, gravel in west end of lake.
Inlets, there are several small inlets and one large one, which is the outlet of Thompson's lake; outlet, one, a branch of Fawn river.
Dates of examination, Aug. 3, 4, 5, 6, 7 and 8.
Weather, 3, 4, 6, 7 and 8, clear; 5, cloudy.
Temperature, surface, 3, 4 and 7, 82°; 5 and 6, 81°; 8, 80°; bottom, 46°.
Water, clear.

Fish, small-mouth bass, blue-gills, herring, bullheads, suckers, rock bass and strawberry bass. The fish are all very fat and show large growth. The small-mouth bass are very large.

Long Lake, Fabius Township:

Length, 1 mile; width, ¼ mile.

Shores are hard and sandy, high banks extend all around the lake.

Bottom, soft through the center of the lake; near shores is hard and sandy.

Inlets, none; outlets, none.

Dates of examination, Aug. 17 and 18.

Weather, rainy.

Temperature, surface, 17, 76°; 18, 74°; bottom, 51°.

Water, clear.

Fish, perch, blue-gills, shiners, bullheads and rock bass. Perch in good condition, blue-gills are small.

Long Lake, Colon Township:

Length, 1½ miles; width, ¼ mile; greatest depth, 40 feet.

Shores, high banks extend nearly around the lake, marsh extends about 40 rods on south shore.

Bottom is mud all over the lake.

Inlet, Swan creek; outlet, a large stream emptying into Palmer's lake.

Dates of examination, July 26, 27 and 28.

Weather, clear.

Temperature—surface, 26 and 27, 78°; 28, 79°; bottom, 52°.

Water, clear.

Fish, grass pike, blue-gills, bullheads, suckers and strawberry bass. The fish taken are hard and in good condition; the grass pike show great growth.

Palmer's Lake, Colon Township:

Length, 1½ miles; width, ½ mile; greatest depth, 55 feet.

Shores, high banks all around the lake, sand and gravel on all shores.

Bottom, hard, sand in northern part, stony in southern part.

Inlets, channel from Long Lake; outlets, channel emptying into Sturgeon lake, thence into St. Joseph river.

Dates of examination, July 28 and 29.

Weather, clear.

Temperature—surface, 28, 80°; 29, 78°; bottom, 48°.

Water, clear.

Fish, grass pike, blue-gills, sunfish, bullheads, strawberry bass, gar pike and dog-fish. The fish are in good condition; the grass pike show great growth; sunfish are small.

Pickerel Lake, White Pigeon Township:

Length ¾ mile, width ½ mile, greatest depth, 20 feet.

Shores, marshy on south side, high banks on north and flat on east and west.

Bottom, muddy, except on north side, which is sandy.

Inlets, one small stream on south side, which is the outlet of Aldrich lake; outlet, into Fawn river.
The lake is said to contain grass pike, bullheads, perch and blue-gills.

Pleasant Lake, Fabius Township:
Length, 1 mile; width, 100 rods; greatest depth, 49 feet.
Shores, muddy; flat marshy banks extend all around the lake.
Bottom, soft muddy bottom.
Inlets, none; outlet, is a large ditch running into St. Joseph river.
Dates, August 15, 16 and 17.
Weather, clear.
Temperature—surface, 15,76°; 16, 74°; and 17, 16°; bottom, 15, 16, 48°, and 17, 49°.
Water, clear.
Fish, perch, blue gills, whitefish and large-mouth bass. Fish in good condition and all show very large growth.

Sand Lake, Nottawa Township:
Length, ¾ mile; width ½ mile; greatest depth, 34 feet.
Shores, gravel and sand; high banks all around the lake.
Inlets, none; outlets, none.
Dates of examination, August 1 and 2.
Weather, clear.
Temperature—surface, 1, 82°; 2, 80°; bottom, 70°.
Water, clear.
Fish, large-mouth bass, blue-gills, gar pike and bull-heads.
The fish are all in good condition and well fed.

Sturgeon Lake, Colon Township:
Length, 1 mile; width, 100 rods; greatest depth, 34 feet.
Shores, marsh extends nearly around; high banks extend a short distance on east and west.
Bottom, soft and grassy, except near the inlet it is sandy.
Inlet, St. Joseph river; outlet, St. Joseph river.
Dates of examination, July 29, 30 and 31.
Weather, clear.
Temperature—Surface, 83°; bottom, 66°.
Water, clear.
Fish, grass pike, strawberry bass, large-mouth bass, blue-gills and suckers. Grass pike are hard and show great growth; blue-gills and strawberry bass show small growth; suckers are very large and all are well fed.

Sweet's Lake, Fawn River Township:
Length, ¾ mile; width ½ mile; greatest depth, 23 feet.
Shores, high banks and timbered on north and south sides; east, flat banks and west low banks.
Bottom, soft, grassy, and one sand bar.
Inlets, none; outlet, Fawn river.
Date of examination. July 22.
Weather, clear.
Temperature—Surface, 80°; bottom, 76°.
Water, clear.

Fish, large-mouth bass, blue-gills, perch, suckers, shiners, bull-heads and dogfish. Bass were in good condition; blue-gills were poor and small; suckers were in good condition.

Thompson's Lake, Sherman Township:
Length, ¾ mile; width, ½ mile; greatest depth, 36 feet.
Shore, marshy on east and west; north and south, high banks and sandy shores.
Bottom, hard and sandy, with rushes extending out from shore.
Inlet, one; a small inlet fed by springs around the marsh; outlet, small stream emptying into Middle lake, thence into Klinger lake.
Dates of examination, August 4 and 5.
Temperature—Surface, 4, 80°; 5, 79°; bottom, 4, 59°; 5, 58°.
Water, clear.
Fish, blue-gills and herring. Blue-gills were well fed and show large growth; herring were soft but in good condition.

Van Buren County.

Great Bear Lake, Columbia and Bloomingdale Townships:
Length, 1 mile; width, ½ mile; greatest depth, 54 feet.
Shores, gravel and sandy except about 20 rods at outlet, marshy; high clay and sandy banks; wooded on south and east.
Bottom, sand and gravel for 15 or 20 rods around the shores; through center clay covered 6 to 8 inches with black mud.
Inlet, there is one large inlet on east side coming from Lake Mill; outlets, one large outlet, a tributary to Black river, thence into Lake Michigan.
Dates of examination, Oct. 22, 23, 24 and 25.
Weather, 22, 24 and 25, clear; 23, rainy.
Temperature, surface, 22, 52°; 23 and 24, 50°; 25, 49°; bottom, 22, 48°; 23, 48°; 24 and 25, 47°.
Water, clear.
Fish, strawberry bass. The fish taken were fat and well fed, but show small growth.

Jep Lake, Columbia Township:
Length, 3 miles; width, ¼ mile; greatest depth, 44 feet.
Shores, sandy and high banks on south and east; north and west flat muddy banks.
Bottom, muddy all over the lake and covered with moss and weeds.
Inlets, none; outlets, one on north side, a large ditch cut to drain lake.
Dates of examination, Oct. 18 and 19.
Weather, clear.
Temperature, surface, 54°; bottom, 43°.
Water has a reddish color.
Fish, blue-gills, perch and large-mouth bass. The fish taken were in good condition but small growth.

North Lake, Columbia Township:
This lake has been drained.

Pleasant Lake, Bangor Township:
Length, 100 rods; width, 40 rods; greatest depth, 24 feet.

Shores, marshy.
Bottom, mud.
Inlets, none; outlets, none.
Date of examination, October 17.
Temperature—surface, 54°; bottom, 49°.
Fish, blue-gills, perch, bullheads and black bass.

Silver Lake, Columbia Township:
This lake has been drained by ditches so there is but little left of it.

Rush Lake, Bangor Township:
Length, ¾ mile; width, ¼ mile; greatest depth, 57 feet.
Shores, muddy, with flat marshy banks all around the lake.
Bottom, marl, covered with moss and weeds near shores.
Inlets, none; outlets, one, a ditch made to drain the lake.
Dates of examination, October 13 and 14.
Weather, clear.
Temperature—surface, 13, 56°; 14, 54°; bottom, 49°.
Water, clear.
Fish, blue-gills, bullheads, suckers and grass pike. The fish taken were hard and fat and show large growth.

Saddle Lake, Columbia Township:
Length, 1¼ miles; width, ½ mile; greatest depth, 28 feet.
Shores, sand and marl, with high banks all around, wood on north and east.
Bottom, marl.
Inlets, none; outlets, one small stream emptying into Black river.
Dates of examination, October 19, 20 and 21.
Weather, 19, clear, 20, rain, 21, snow.
Temperature—surface, 19, 54°; 20, 53°; 21, 50°; bottom, 50°.
Water, clear.
Fish, perch, blue-gills, sunfish, bullheads, shiners and gar-fish. The fish taken are well fed and show large growth.

School Section Lake, Bangor Township:
Length, ½ mile; width, 100 rods; greatest depth, 10 feet.
Bottom, muddy, weeds reach nearly to the surface. It has been drained.
Date of examination, October 17.
Some few native fish remain, such as blue-gills, sunfish and a few black bass, etc.

Lake 14, Bangor Township:
Date of examination, October 24.
This lake has been drained so low that no fish except carp can live in it.

Scott Lake, Arlington Township:
Length, 1 mile; width, ¼ mile; greatest depth, 54 feet.
Shores, sand, with high banks on north and south; wooded on the east and south.
Bottom, mostly marl; there are some places in deep water where there is a black mud bottom.

Inlets, there is one small inlet on east side, the outlet of some small marshes close to this lake. Outlets, there is one outlet on northwest corner. It is a county ditch running into Black river, thence into Lake Michigan.
Dates of examination, October 14, 15 and 16.
Temperature—Surface, 14 and 15, 56°; 16, 55°; bottom, 14 and 15, 50°; 16, 49°.
Water, clear.
Fish, perch, strawberry bass, bull-heads, blue-gills, grass pike, large-mouth bass, sunfish and red bass. The fish taken were in good condition, well fed, but small growth, except grass pike are very large.

Sister Lake, Keeler Township:
Length, ½ mile; width, ¼ mile; greatest depth, 32 feet.
Shores, sand and gravel; high sandy banks except about 20 rods on west, flat and marshy; wooded on south.
Bottom, sandy near shore, with sand bar crossing near west end; through center muddy and covered with weeds.
Inlets, none; outlets, none.
Dates of examination, September 11 and 12.
Weather, clear and cold.
Temperature—Surface, 11, 64°; 12, 63°; bottom, 11, 60°; 12, 59°.
Water, clear.
Fish, perch, blue-gills, sunfish, strawberry bass and large-mouth bass. The fish taken were hard and well fed, but show small growth.

Vanauken Lake, Bangor Township:
Length, 1 mile; width, ½ mile; greatest depth, 47 feet.
Shores, hard sand on east and south; north and west, flat muddy banks all around.
Bottom, nearly all hard and sandy except a small portion in northwest corner, which is soft and muddy.
Inlet, there is one small spring creek running in on south side; outlet, one on west side. It is a large ditch cut to drain the lake.
Dates of examination, October 11, 12 and 13.
Weather, cold; 11, cloudy; 12, rainy; 13, clear.
Temperature—Surface, 11, 58°; 12, 57°; 13, 54°; bottom, 11 and 12, 50°; 13, 49°.
Water in this lake has a reddish color.
Fish, grass pike, blue-gills, bull-heads, perch, strawberry bass and suckers. The fish taken were hard and well fed; the blue-gills and strawberry bass were small; the pike large.

V.—EXAMINATION OF INLAND LAKES

2. Work of 1888.

In December, 1887, the newly appointed United States Commissioner of Fish and Fisheries, Col. Marshall McDonald, had visited Detroit with Mr. Richard Rathbun, the Assistant in charge of Scientific Research, at which time they had discussed with members of this board the methods we had employed in examining the inland lakes. The systematic and thorough manner

of doing that work was specially commended by them and the results promised by it were regarded as of great practical value. Col. McDonald was so much interested in it, and the opportunities offered for extended scientific observation connected with the purpose of the examination that he proposed co-operating with us by furnishing a naturalist. The terms and objects of such co-operation were further considered by subsequent correspondence, and in May, 1888, at the meeting of the American Fisheries Society, at which Col. McDonald and Mr. Rathbun were present, arrangements were finally concluded by which the United States Commission agreed to furnish a naturalist, and bear one quarter of the actual expenses, not including salaries, and the Michigan Commission agreed to furnish a crew of four men and a cook, besides necessary camping outfit and our implements for fishing, sounding and recording temperatures.

The instructions of the United States Commission to the naturalist, and of this commission to the crew on the subject of the joint work, are printed in the appendix to this report. Mr. Charles H. Bollman, a student under Dr. Jordan at the University of Indiana, was employed as naturalist. His work was satisfactorily performed, and his report was expected in time for this publication.

Operations were commenced early in July in Kalamazoo county, where they were stopped the previous year. The regular work of the crew was prosecuted in Kalamazoo county and Calhoun county until August 6, when they were moved to Torch Lake for special work, which was deemed important. Abstracts of the reports of the crew are given in full below. While all of these reports will not be of special interest to all readers, each one of them will be of interest and practical value to some citizens of the state; and it is also a matter of great convenience to have them in print for reference.

The special examinations referred to above are those of lakes of unusual importance by reason of their size, the large plants made in them, or the promise, if we find some of them specially adapted, to making experiments on a large scale. It is the purpose of the board to continue the examinations year by year until the entire state has been covered. This course, if thoroughly carried out, will never require to be done again, and will result in placing on record all that need be known by the state fishery officers to enable them to deal justly and intelligently with the entire lake system of the state. The instructions, it will be seen, contemplate some investigations of the streams that are found by the crew while engaged in their lake work. This feature of the examinations becomes very important when it deals with the larger streams or rivers, because the physical characteristics of a large stream are less easily observed and less likely to be reported upon accurately in the circular reports which are received from individuals who apply for plants of fish. The utility of an exact record in our office of all the streams in the state is of the same kind as the record now being made of the inland lakes. It would be an unerring guide to the kinds and quantities of fish asked for, or sent out from the state hatcheries.

The co-operation of the United States Fish Commission in this kind of work was very acceptable to this board, as it enabled us to enlarge the field of our common labors, and afforded an opportunity to demonstrate the possibility of the two organizations uniting their efforts to attain a useful object of common interest with an important saving in the needful expenditure. The general subject of co-operation in fish culture by the existing agencies

employed in its prosecution is discussed at more length in an article contained in the appendix. This board has sought to enlist the interest of the University and the Agricultural College in the subject of these examinations, and to improve the character of the work by securing their co-operation. The proposal came too late in the season to be successful, but we have hopes of securing the co-operation of one, at least, of the state colleges for the next season, as President Willits, of the Agricultural College, has proposed to supply the position of naturalist in our crew with the Professor of Natural History of that college. If the proposed arrangement can be carried out it will result in a mutual advantage to both institutions.

The condensed reports of 1888, given below, show that the genuine black bass is found in three of the lakes reported upon; herring in three lakes; whitefish in two, and wall-eyed pike in one.

Kalamazoo County.

Eagle Lake, Texas Township:
Length, ¾ mile; width, ½ mile; greatest depth, 20 feet.
Shores, sand and high banks; wooded on south and east.
Bottom, soft, muddy, covered with weeds and grass.
Inlets, none; outlets, none.
Date of examination, July 18, 1888.
Weather, clear.
Temperature—surface, 75°; bottom, 70°.
Water, clear.
This lake contains a few native fish, but the water is very shallow and gets so warm that the fish get soft during the summer months and are not good to eat.

Long Lake, Pavilion and Portage Townships:
Length, 2 miles; width, ¾ mile; greatest depth, 42 feet.
Shores are generally marshy or springy, with patches of sand and gravel, with bulrushes all around the lake.
Inlets, none; outlet, it has one that flows from the south end of lake into Austin lake, nothing more than a ditch.
Dates of examination, July 8, 9, 10, and 11.
Temperature—surface, 8 and 9, 73°; 10 and 11, 74°; bottom, 8, 10 and 11, 52°; 9, 53°.
Water, clear.
Fish, perch, blue-gills, sunfish, strawberry bass, large-mouth bass, small-mouth bass and bullheads. The fish taken were very fat, flesh hard and showed large growth.

Gourd Neck Lake, Portage and Schoolcraft Townships:
Length, 1¼ miles; width, ½ mile; greatest depth, 50 feet.
Shores, sandy on north and north-east, with high banks; flat banks and marshy on west, south and south-west.
Bottom, hard, sandy in north end; black, soft mud in south end.
Inlets, one spring creek emptying into west side, and a channel from Hogshead lake on north end; outlet, one small stream flowing south into Rawson lake.

Dates of examination, July 12, 13 and 14.
Temperature, surface, 12, 75°; 13 and 14, 73°; bottom, 12, 50°; 13 and 14, 49°.
Water, clear.
Fish taken, wall-eyed pike, blue-gills, grass pike and large mouth bass. The fish were hard, well fed and showed large growth.

Indian Lake, Pavilion and Brady Townships:
Length, 2¼ miles; width, 1 mile; greatest depth, 76 feet.
Shores, for from one to six rods all around the lake are low and marshy, back of that high banks.
Bottom, in east end soft mud; in deep water in body of lake, hard clay and marl.
Inlets, two; Portage and Beaver creeks coming in on the north side; mud bottom and grown with weeds; outlets, one; on south side of north arm, flowing into Portage river.
Dates of examination, July 11 and 12.
Temperature, surface, 11, 72°; 12, 73°; bottom, 54°.
Water, clear.
Fish taken, herring, suckers, rock bass, bullheads, black bass, grass pike and perch. The fish are well fed.

Crooked Lake, Texas Township:
Length, 1¼ miles; width, ½ mile; greatest depth, 50 feet.
Shores, sandy, with high sandy banks; wooded on south and about ¼ mile on north.
Bottom, sand and gravel for ten or fifteen rods out from shore; soft black mud through middle of lake.
Inlets, none; outlet, one; a small stream emptying into Bass lake.
Dates of examination, July 18 and 19.
Temperature—Surface, 18, 75°; 19, 73°; bottom, 18, 55°; 19, 54°.
Water, clear.
Fish taken, blue-gills, sunfish and bull-heads. The blue-gills and sunfish were hard and very fat, well fed and showed large growth.

West Lake, Portage Township:
Length, 1 mile; width, ¾ mile; greatest depth, 14 feet.
Shores, sandy; flat banks except about ½ mile on south shore, which is high banks; wooded on north and west.
Bottom, soft and muddy.
Date of examination, July 16.
Temperature—Surface and bottom, 73°.
Water, muddy.
This lake is said to contain blue-gills, sunfish, suckers, large-mouth bass and some other species of native fish. No net was put in this lake, as the water is shallow and the bottom covered with weeds. It has been lowered by ditching so that the lake is nearly destroyed.

Austin Lake, Portage and Schoolcraft Townships:
Length, 3 miles; width, 1½ miles; greatest depth, 14 feet.
Shores, flat and marshy; low banks all around the lake.
Bottom, soft and muddy; grass and weeds all over the bottom.

Inlets, one small inlet flowing from West lake; outlet, one channel flowing into Long lake.
Dates of examination, July 12 and 13.
Temperature, surface, 12, 75°; 13, 74°; bottom, 70°.
Water, muddy.
Fish taken, large-mouth bass, rock bass, blue-gills, bull-heads, gar pike, sunfish and dogfish.
The sunfish, blue-gills and bass, were well fed, but soft and of small growth.

Howard Lake, Schoolcraft Township:
Length, ¾ mile; width, ¼ mile; greatest depth, 46 feet.
Shores, soft and springy close to water's edge; high clay and sandy banks, wooded on north, east and south.
Bottom, on north soft and grass for ten or fifteen rods; balance of lake is marl and black mud.
Inlets, two; one a small spring creek emptying into west side, and one a large stream flowing in on east shore; outlets, one, a large stream flowing into Rawson lake.
Dates of examination, July 18 and 19.
Temperature, surface, 18, 73°; 19, 72°; bottom, 44°.
Water, clear.
Fish taken, long-jawed whitefish and perch.
The whitefish taken were in the best of condition.

Rawson Lake, Schoolcraft Township:
Length, 1¼ miles; width, ½ mile.
Shores, on north end are flat and marshy; on south side, tamarack swamp; on north side high banks.
Bottom, in deep water hard marl; in shallow places, mud covered with weeds.
Inlets, two, one in north end coming from Gourdneck lake, and one in south end coming from Howard lake; outlets, one on the south side flowing into Kimball's lake.
Dates of examination, July 16, 17, 18 and 19.
Temperature, surface, 16 and 19, 73°; 17, 72°; 18, 74°; bottom, 16, 51½°; 17, 52°; 18, 53°; 19, 51°.
Water, clear.
Fish, suckers, calico bass, blue-gills, sunfish, bullheads, herring, grass pike, and perch.
The fish taken were plump with stomachs full.

Calhoun County.

Goguac Lake, Battle Creek Township:
Length, 1¾ miles; width, ½ mile; greatest depth, 65 feet.
Shores are sand and gravel except on south end of lake, where it is low and marshy.
Bottom, is sand, gravel and marl in shallow water; in deep holes, mud.
Inlets, none; outlets, none.
Dates of examination, July 20, 21, 22, 23, 24 and 25.

Temperature—Surface, 20, 21 and 23, 73°; 22 and 25, 74°; 25, 75°; bottom, 20 and 23, 44°; 21, 48°; 22, 45°; 24, 51°; 25, 43°.
Water, clear.
Fish, gar pike, swamp bass, perch, bull-heads, blue-gills and sunfish. The fish were small but plump and well fed.

Barnum Lake, Leroy Township:
Length, 1¼ miles; width, ⅓ mile.
Shores, marshy or grown with rushes around the entire lake.
Bottom, soft mud and marl.
Inlets, one coming into south end from Pane's lake; outlets, one flowing from north end into Kalamazoo river.
Date of examination, July 22.
Temperature—Surface, 73°; bottom, 49°.
Water, clear.
Fish, suckers, perch, blue-gills, swamp bass, eels, sunfish and rock bass.

St. Mary's Lake, Pennfield and Bedford Townships:
Length, 1 mile; width, ¼ mile; greatest depth, 24 feet.
Shores, are sand, gravel and rocky all around the lake, with high, sandy banks.
Bottom, along the shore is hard, but after leaving the offset, is soft mud.
Inlets, none; outlets, none.
Dates of examination, July 24 and 25.
Temperature—Surface, 74°; bottom, 24, 54°; 25, 53°.
Fish, blue-gills, bull-heads, perch, swamp bass and chubbs. Fish are good size and well fed.

Hart's Lake, Battle Creek Township:
Length, ½ mile; width ¼ mile; greatest depth, 45 feet.
Shores, flat and marshy all around the lake.
Bottom, soft mud and marl, covered with a short growth of weeds.
Inlets, one, coming in on south side, a small spring brook; outlets, one, flowing into Kalamazoo river.
Date of examination, July 27.
Temperature—Surface, 75°, bottom, 48°.
Took no fish. The fish are all native.

Panes Lake, Le Roy Township:
Length, 1 mile; width, ¼ mile; greatest depth, 42 feet.
Shores, marl and mud, grown with pond lilies and rushes around the entire lake.
Bottom, mostly marl, with mud in the deepest parts.
Inlets, none; outlets, one, flowing from south end into Barnum lake.
Date of examination, July 24.
Temperature—Surface, 73°; bottom, 49°.
Water, clear.
Fish, small-mouth bass, suckers, perch, swamp bass, sunfish and blue-gills.
Fish are plump and well fed.

Lyon Lake, Fredonia Township:
Length, ½ mile; width, ⅓ mile; greatest depth, 30 feet.

Shores are gravel and sand, with rushes on southwest side, with high banks all around the lake.
Bottom is hard sand and marl on offset and is a dark kind of marl or dirt in deep places, which is hard.
Inlets, none; outlets, none.
Dates of examination, August 1 and 2.
Temperature—Surface, 76°; bottom, 67°.
Water, clear.
Fish, perch, swamp bass, calico bass, blue-gills, bullheads, golden shiners and sunfish. The fish are of good size, the perch averaging one pound, and are well fed, their stomachs being found full.

Upper and Lower Brace Lakes, Townships of Fredonia and Eckford:
Length, Upper lake, ¾ mile; Lower, ½ mile; width, Upper lake, ½ mile; Lower, ¼ mile.
Shores are marl all around both lakes, except on the east side of the lower one, where is a little sand and gravel.
Bottoms are a sort of sand and marl mixed, which is soft and has a terrible smell when stirred up.
Inlets, none natural, but there is a ditch coming into the upper lake from a small lake; outlets, one, which is a ditch cut through to Wilder's creek to lower the lakes.
Dates of examination, July 30, 31 and August 1.
Temperature—Surface, 30, 78°; 31, 76°; bottom, 30, 56°; 31, 58°.
Water, clear.
Fish, blue-gills, swamp bass, grass pike, bullheads, suckers and red-horse. The fish are generally small, but well fed.

Antrim County.

Torch Lake:
Length, 18 miles; width, 2¼ miles; greatest depth, 320 feet.
Shores are sand and gravel around entire lake, with a few places of clay.
Bottom is a mixture of gravel, marl, clay, sand and stone covered in places with weeds.
Inlets, several small spring streams coming in on east side, and Clam river on same side; outlet, one, Torch river, flowing from south end of lake into Round lake.
Dates of examination, August 10, 11, 12, 13, 14, 15, 16, 17, 18, 25, 27 and Sept. 2, 3 and 4.
Temperature, surface, from 67° to 69°; bottom, from 48° in depth of 100 feet to 32½° in depth of 210 feet.
Fish, lake trout, whitefish, herring, lings, perch and suckers. The stomachs of the fish were full, but the fish were not as plump as those of the great lakes.
The food found in the stomachs of the lake trout consists entirely of small fish, chiefly young herring. The same was true of the ling except that they also contained more of the millers' thumbs found in deep water. Whitefish and herring were feeding on crustaceans and the little worm called the whitefish worm.

The land around the lake is generally high, it being mostly hilly, consisting of sand and clay in strips varying from one fourth to two miles wide, with still considerable timber along the east shore. The timber is a mixture of maple, beech, oak, hemlock, and in fact all species of forest timber of Northern Michigan. The shores have a narrow strip of gravel and sand all around the lake, where, in some places, it is mixed with clay and large boulders.

The offset is a gradual slope from the water's edge, in some places running out as far as one-fourth of a mile and in others only for a few feet, then dropping nearly straight down into from forty to sixty feet of water, and at Anderson's camping ground there are one hundred and ninety feet of water within eight rods of the shore.

The lake has been fished by the crew in all ways known to them. Trolling along offset with minnow and spoon. Small-mouth bass were taken, two on spoon and three on minnow, the minnows usually being perch from three to five inches long. Deep draft trolling was done in from one hundred to three hundred feet of water with live bait, by which eight lake trout were taken weighing from four to nine pounds.

VI.—1. RAILWAY CAR FOR USE OF THE COMMISSION.

CAR.

Since the organization of the commission the necessity has been apparent that the state should own a car for the transportation of the fry of the whitefish and trout hatched yearly. This work has always been done through the courtesy of some railroad—largely through the courtesy of the G. R. & I. in renting to the board during the planting season one or more baggage cars for its use. This means of transportation has been very uncertain. The distributions are usually made during the season of the year when roads have a heavy demand upon them for the use of their entire outfit of rolling stock. As a consequence, nothing but the poorest cars can be had, and as these cars are always run, when loaded with fry, in passenger trains, they must be in good condition or are liable to be set out of the train at any point where inspection of cars is had while in transit. The different companies demur very much to the hauling of these cars in passenger trains, and last spring it was only through persistent telegraphing on the part of the employés in charge of such a car, which was in a defective condition, that consent was finally obtained from the railroad authorities permitting the car to go on, and this was coupled with the statement that it was liable to be set out at the next place of inspection, although they would endeavor to see it was not done. If the car had been set out it would have resulted in the loss of between two and three million of fry.

It has always been necessary to procure passes for each trip for the employés sent over the road with the car, resulting in more or less friction and delay, and in one or two instances passes have been absolutely refused.

The commission has long been of the opinion that if it possessed a car of its own the possibilities of enlarging the work would be very greatly increased. Under the past order of things neither the German carp nor the wall-eyed pike could be distributed by the commission, parties desiring these fish being compelled to either be to the expense of going for the fish personally, or paying express charges thereon. The commission has also been precluded from making distributions of the black bass from waters which were well stocked to those that had been exhausted, which would be made possible provided it had a car of its own.

At the last session of the legislature and near the close of the session, the commission was notified by the various railroads in the state that under the Interstate Commerce Act they must withdraw all passes heretofore granted to employés of the board. The board at once upon consultation with the fisheries committee of the legislature, submitted an estimate additional to the amount already asked for to cover this item of expense, amounting to about $6,000, and the same was allowed to the board. The railroads took this precaution, being uncertain as to what effect the Interstate Commerce Act would have upon their business. Sometime after the adjournment of the legislature some of the roads expressed a willingness to grant passes and after a time the courtesy was renewed by nearly all the roads. This left at the command of the commission a portion of this amount of money, and after fully considering the matter it was concluded that the best interests of the state would be subserved if a car could be purchased or built that would answer the purposes of the board in its work. Plans were accordingly made and bids were solicited from various car companies throughout the country and a contract was finally entered into with the Litchfield Car Company of Litchfield, Illinois, who are largely engaged in constructing special cars, for the construction of a car according to the plans submitted by the board. None of the car companies in Michigan that were applied to would accept the contract at all, for the reason that they were too busily engaged upon other work. The bid of the Litchfield Car Company was $1,000 lower than the next lowest bidder, and the contract was finally let to them for the sum of $3,550.

The car was completed and delivered to the board on the 1st of August, 1888. It is 55 feet long, 9 feet 8 inches wide, is plainly and substantially constructed and is calculated for service. It is fitted out with first class passenger coach trucks, with air brake, platforms, coupler and buffers so that it can be easily hauled in any passenger train. It is provided in one end with an office, and in the other with a kitchen, thus enabling the men to live upon the car while upon the trips, materially reducing the expenses of traveling. It is fitted with five berths for the accommodation of the men and the body of the car is so constructed as to carry 175 cans. This largely increases the number of fry we have been able to carry in the ordinary baggage cars heretofore used. It will be thus seen that there is a material saving in the expenses of the men who accompany the car, they being lodged and fed on board the car. It also obviates the necessity of procuring passes for the men, as all that is necessary is to procure an order from the superintendent of the road to have the car hauled. The railroads over which our work is done express great satisfaction with the board in having a car made and say they are entirely willing to haul it in any train they may have. The exterior appearance of the car is very neat and attractive. The car has been named "Attikumaig,"

being the Chippewa name for whitefish, as given by Schoolcraft, its literal interpretation being "Deer of the water."

The car was finished and delivered as early as possible after the contract was made, but owing to the lateness of the season, we were not able to make as great use of it in the distribution of black bass as we shall be in future years. Distributions were, however, made of about 1,600 black bass, the details of which distribution appear in another part of this report.

At some time during the coming session of the legislature the car will be brought to Lansing for an inspection by the members of the legislature.

The board contemplates that the efficiency of the work in the distribution of food and game fishes will be greatly increased by the use of this car, and that the wisdom of its purchase will be apparent. The same company constructed a like car for the Missouri Fish Commission two years ago, which cost them $1,000 more than this car cost the Michigan Commission.

AID FROM MICHIGAN RAILROADS.

Nothing has been more gratifying to the board than the interest shown by the railroads of the state. Recognizing, as they do, the universal benefits which surely follow the work of the commission, they have been ever ready to help the board, carrying our men, our fish and cans, our camp outfit and baggage, hauling our cars and in every possible way contributing their full share of assistance, free of charge, saving to the state several thousands of dollars each year, thus enabling the board to increase the work by just the amount saved. The board being limited to the appropriations made by the legislature would sometimes have to leave important things undone if it were not for the hearty coöperation of the railroads.

The Grand Rapids & Indiana and the Detroit, Lansing & Northern roads have been most frequently called upon because the line of our most frequent travel is over these roads. No refusal has ever been received from either of these roads, in fact no road in the state has refused a request, but all have been prompt and generous to answer any demand made upon them.

Besides the railroads above named, the board are under obligations to the following for favors received and courtesies extended to the officers and men belonging to this commission:

The Detroit, Marquette & Mackinac; the Detroit, Bay City & Alpena; Detroit, Grand Haven & Milwaukee; Flint & Pere Marquette; Lake Shore & Michigan Southern; Michigan Central; Chicago & West Michigan; Marquette, Houghton & Ontonagon; Toledo, Ann Arbor & Northern; Michigan & Ohio; Chicago & Northwestern; Saginaw, Tuscola & Huron; Pontiac, Oxford & Port Austin; Wabash, St. Louis & Pacific.

Respectfully submitted,

JOHN H. BISSELL,
HERSCHEL WHITAKER,
JOEL C. PARKER.

GRANT OF FISHERY RIGHTS ON THE DETROIT RIVER.

In October, 1888, we became aware that persons who had been holding leases of fishing privileges for a number of years on the Detroit river, which were under the control of the Lighthouse Board, had been notified by the lessors that their privileges would terminate January 1, 1889, when there would be a re-leasing. These privileges had been enjoyed for a number of years by the parties in possession at a merely nominal rental. This board for the past few years has, under arrangement with the different lessees of these fisheries, had the privilege of handling the whitefish taken on these grounds for the gathering of ova, which right has cost the state in the neighborhood of $1,500 to $2,000 yearly. The fisheries which have thus been operated by the commission are known as Grassy Island and Mammy Judy.

In view of the facts that the state for the last ten or fifteen years has been planting large numbers of whitefish fry for the public benefit, at a considerable expense, and that the statistics of the past two years show that this money has been expended judiciously, and fishermen are now reaping an adequate benefit in the enhancement of the value of their fisheries, it has seemed but justice to the state that the operations of spawn gathering should be enjoyed by the commission without expense, and if necessary, authority should be given the board by statute, to enter upon any fishing grounds within the borders of the state, at their pleasure, for the purpose of gathering the ova of the whitefish without expense. Undoubtedly legislation of this kind would meet with some opposition were it proposed, and very fortunately the necessity for legislation of this kind has been obviated, for the present at least, by the securing of the right hereinafter mentioned.

To intelligently understand the value of the grant we have obtained it is only necessary to say that, owing to the sheltered locality of the fisheries on the Detroit river and the certainty with which the ova can be procured, it has grown to be a very desirable place to conduct such operations, and during the past fall, in addition to our own work done on the river, the United States Commission, the Wisconsin Commission and the Canadian authorities have all conducted spawn-gathering operations at different points between Detroit and the mouth of the river.

Upon learning the intention of the Lighthouse Board to relet these fisheries, steps were at once taken by us to ascertain if we could not secure the right to operate upon these grounds, for the purpose of gathering the ova without expense to the state, and the following petition was addressed to the Lighthouse Board:

DETROIT, MICH., *November 12, 1888.*

To the Lighthouse Board:

GENTLEMEN:—It has come to the knowledge of our board that parties holding leases of fishery rights on the Lighthouse Reserve on the Detroit river, have been notified that their leases would expire on the 1st of January, 1889, and that these rights will be open to competition after that date.

You are probably aware that the state of Michigan, through this board, has been engaged in the business of restocking the Detroit river and adjacent connecting waters with whitefish, for the last twelve or fourteen years, and that the result of this work is being felt very noticeably this present season.

Very many fisheries along the river that had been abandoned for a number of years, are being fished at a profit this year, which is attributable wholly to artificial propagation. For the past five years the principal part of our egg-taking operations have been conducted upon the Detroit river, and we have handled the fish taken at the fisheries along the river, which are leased from your board.

We desire very much to continue in the enjoyment of this right, and having been apprised of your notification to the parties now holding the leases, we desire to petition your board to secure to us, for the state, the right in the future to handle such fish as we may desire for the purposes of artificial propagation, at the various fisheries under the control of your board, without expense to the state. Our work is entirely in the interests of maintaining the whitefish industry of the great lakes and connecting waters, and our success results in the improvement and enhancement of the value of all the fisheries upon this river.

We would therefore respectfully request that your honorable board grant to the Michigan Board of Fish Commissioners, the right to enter upon the premises during the fishing seasons, and handle such fish as they may desire free of charge; and that in making leases, to such parties as may secure the right from your board to fish upon these premises, you will make it a condition of such leases that they shall be subject to the right granted to the state. We will also agree to plant upon these grounds each year a liberal supply of fry to maintain good fishing at these places.

Trusting our request will meet with your favorable consideration, I remain,

Very respectfully yours,
HERSCHEL WHITAKER,
Commissioner.

This petition was promptly considered and after a brief correspondence, and on Dec. 12, 1888, the following communication was received:

WASHINGTON, *Dec. 12, 1888.*

MR. HERSCHEL WHITAKER, *Michigan Fish Commission, Detroit, Mich.:*

SIR:—Referring to your letter of 12 Nov., '88, the Board has directed the engineer of the tenth light-house district, Cleveland, Ohio, to insert in any lease or leases that may be granted for the fisheries in the Detroit river, over which it has control, a condition that the premises leased shall be subject to entry, etc., for the purposes of your commission, as requested by you.

Respectfully yours,
JAMES F. GREGORY,
Major of Engineers, U. S. A. Engineer Secretary.

By this action the state has acquired a most valuable right, and the thanks of this board are due to the courtesy of the Lighthouse Board for their very prompt and cheerful compliance with our petition. The kind offices of Commander C. V. Gridley, of Buffalo, N. Y., officer in charge of this department, and of Commander Horace Elmer, of Detroit, for their assistance in this matter, are hereby duly recognized and our thanks are extended to them for their courtesy. The obligations of the commission to Senator Stockbridge for his kind offer of assistance are also hereby duly recognized.

In Memoriam.

In making our report of the results of the work of the board for the past two years, we should stop much short of our duty were we to pass by unrecognized the death of Seth Green, the most eminent fish culturist of America, without a fitting recognition of his great services in the development of the methods of artificial propagation of our food and game fishes.

It is of little consequence where such a man may have been born or where he died; he belonged to the world at large; in a sense he had become a public character by reason of his identification with a question in which the public is largely interested, and as he had in a measure become public property, the place of his birth or death are matters which concern none but those immediately connected with him.

It has been well said that "He who causes two blades of grass to grow where one had grown before is a public benefactor," and in this light Mr. Green was a public benefactor in the fullest sense. Of him it may be said that he caused to grow thousands, where one had grown before.

He loved nature in all her varying moods; he loved the sports of stream and field, and was an adept with rod and gun. He was a man of keen and close observation, and was possessed of that quality which makes men great—the power to grasp and apply acquired information to practical uses. For nearly or quite a quarter of a century he was engaged in experimental work connected with the artificial propagation of the food and game fishes of America, and without question it may be said that few, if any, were better acquainted with their habits, their distribution and peculiarities than he.

Mr. Green was not the discoverer of the artificial propagation of fishes, but up to the time he engaged in fish culture it had barely advanced beyond the field of pleasing and successful experiment. Under the methods then known and used the results of propagation had never

shown a greater percentage of impregnation in a given quantity than about 20 to 30 per cent. He at first succeeded no better than those who had preceded him, but his practical mind soon suggested to him that with such results no advancement adequately necessary to restock exhausted waters could be accomplished, and that the natural spawning habits of the fish were but little improved upon, if at all. Thought and devotion to the work finally suggested to him what is now known to fish culturists as "dry impregnation," and his experiments with this process were soon rewarded with a surprisingly gratifying result. Instead of a percentage of successful impregnation amounting to only about 20 to 30 per cent, he found that the percentage under most favorable circumstances might be raised to even 95 per cent. The necessary and logical result of this discovery suggested to those interested in fish culture, the entire practicability of the different states embarking upon the work of fish breeding upon a large scale, to renew or increase an important food item. State after state has entered upon this work until now there are very few of the states of the Union which have not engaged in fish breeding in some measure. The success of this work has been so manifest that it is entirely within reason to say that despite all obstacles, even those which the laws of well governed states ought to remove, fish culture can restock our depopulated waters.

Mr. Green contributed largely to the literature connected with the subject of fish culture, and was a recognized authority on disputed questions. For many years he was superintendent of the N. Y. hatchery at Caledonia, N. Y., and actively overlooked the general conduct of the station until his death. He has educated many of the best fish culturists of the United States in the rudiments of the business, who are now at the head of important work all over the country.

APPENDIX.

APPENDIX.

1.—FISH COMMISSIONS.—AN HISTORICAL SKETCH.

DR. JOEL C. PARKER.

One of the first and most pertinent questions asked in this utilitarian age, of any investment, whether public or private, is: Will it pay? And of no subject of a public nature has this been asked with more pertinacity than of the establishment, endowment and continuance of the Fish Commissioners in the several states of our union and that of the general government.

It is a fair and honest question, and a sincere desire on the part of the commission of this state to answer it fairly and honestly is the object of this paper; and to do this, it seems quite to the point to review the reasons that first led to the establishment of such commissions; their success and failure so far, and to predicate from what has been done what may reasonably be expected for the future.

It is generally conceded that the first successful modern experiment in the artificial propagation of fish was made by Stephen Ludwig Jacobi at Hoenhausen, in Westphalia, in 1784, and was carried on successfully on the Jacobi estate for a period of more than eighty years; but the time had not yet come when public attention could be aroused to the gradual but sure decrease in the food supply furnished by the waters of the seas and rivers. Although these experiments were known among the more progressive nations throughout the world, yet nearly a hundred years elapsed before any particular attention was again called to this subject. At this time, 1842, an illiterate fisherman living among the mountain streams of the Vosges—Joseph Remy by name—re-discovered the fact that the eggs of the brook trout could be artificially fecundated and hatched, and in conjunction with a companion, Antoine Gehin, the work was carried on until it became publicly known.

This was the germ out of which has grown the extensive and important system of fish culture; for as soon as it was demonstrated that one variety of fish could be successfully increased many hundred fold, the question of why

not others was sure to find an answer. Numerous experimentalists entered into the work, and with such marked success that at the end of four years the French government, recognizing its value as a great public benefit, established the first governmental station and inaugurated the plan of Fish Commissions. This was followed in the same year by Norway, by Finland in 1852, and by the United States in 1853, and since then nearly every government with any commercial fisheries interests have created commissions or in an equivalent way have encouraged and carried on some system of artificial fish propagation as a public benefit. In the United States the several states, recognizing the inability of the general government to carry on a work so vast unaided, and that to a large extent the benefit derived was local, those states having a large pecuniary interest in the growth and capture of the inhabitants of the waters of rivers, seas and lakes, instituted commissions, placing in their hands such sums of money for carrying forward the work as the legislators deemed best. These commissions have from time to time issued reports. These have shown how the money was expended and as far as possible the results obtained.

In 1871 the first proposition to establish a commission was put before the legislature of this state. It met with but little support, and many jokes were launched at its advocates. But in 1873 Hon. Eli R. Miller—who may well be called the father of the Michigan Fish Commission—introduced a bill and pushed it with so much earnestness and enthusiasm, enlisting in his cause, outside of the Legislature, Hon. Geo. H. Jerome, of Niles, and Rev. J. G. Portman, of Benton Harbor, who brought a good deal of enthusiasm and some practical knowledge to bear on the case, and through these efforts the bill passed and became a law. Governor Bagley appointed as commissioners Hon. Eli R. Miller, Hon. Geo. H. Jerome and Hon. George Clark, and the Legislature appropriated the sum of $15,012.50 to inaugurate the work. Since then the work has been carried forward by those having it in charge with that success and failure which must unavoidably attach to any enterprise in which there are many experiments to be tried and many obstacles, due to inexperience, to be overcome. One of the most difficult things that any commission has to deal with is the verification of some portions of their work, especially that into which the most time and money must be put, namely, the planting of fish in immense bodies of water, such as the salt and "unsalted" seas. The field is so vast and the plants so small, comparatively, that of a necessity a long time must elapse, and a careful gathering of statistics, to be as carefully collated and generalized, of the yearly catch of such fish as are propagated and planted, the increase in number and efficiency of all apparatus used in their capture, before any data can be formulated in which we can say we *know*, because it is a matter of mathematical demonstration.

That which sustains and upholds us, and gives us the earnest courage of our convictions, are certain forms of deductive reasoning drawn from observed facts, and a few isolated facts that bear very strongly upon the case. Our deductions are from these and similar premises. It has been stated, and our observations confirm the statement, that not more than one egg of each thousand from a parent whitefish is fertilized and hatched, while by artificial propagation 940 in each thousand are usually hatched. In each female fish there is an average of 25,000 ova, then from this one fish the average hatch will be 24,000 young fish, from each parent, artificially pro-

duced, against 25 in the natural way. It is perfectly plain, then, that the product of one fish artificially handled, is nearly equal to 1,000 fish left to natural methods.

From meagre reports collected, the amount of whitefish caught in 1885-86-87 was 13,572,370 pounds, an average of 4,524,723 pounds for each year. The average weight of each fish is two pounds; 2,262,061 would represent the *number* caught. Admitting that this is an adequate supply for the country, and if continued the supply would remain constant, then the number of female spawning fish necessary to maintain this supply naturally, would be 90,482, and by the artificial method, 100 would suffice. Admitting that by either method the young reach maturity, and the chances are equal, then as soon as it can be ascertained—if it ever can be—how many fish a given area of water will support, it will only be a question of arithmetic as to how many fish we must plant each year to keep up the supply, and just what it will cost to produce them. The most important factor, after all, and the one to which the least attention has been paid, is that of food for the fish we plant; probably the greatest failures made by the commissions are those depending upon a proper food supply. It was almost taken for granted, by all primitive fish culturists, that as all fish lived in water, therefore they would live and thrive in all waters; and so in the early days of fish commissions thousands of fish were planted in unsuitable waters, and failures followed as a matter of course. In this state considerable numbers of whitefish and lake trout were planted in the inland lakes, and with the possible exception of a few planted with whitefish, were blooming failures. The eel experiment was another brilliant generalization. It was well known that the eel lived and throve in the dull, muddy water of the east, and it was very reasonably supposed that if transported a little further west he would be just as prolific and toothsome as in the east; the failure in this case was not one of food, but one of reproduction. We did not know then as well as we do now, that it was the unvarying law of nature that the eel should go to the salt water to propagate his species, and therefore we brought several millions of eels and distributed through the state; they have grown to a large size, many of them, but have failed to furnish any "little ones."

The distribution of the California salmon has been another curious experiment. Planted in our brook-trout streams as "fry," they remained and throve until the second year, when they disappeared entirely. From those planted in this state a few have been captured in the great lakes, these had grown to several pounds weight. In eastern waters, where the conditions seemed as favorable as in the waters of the Pacific, no results were obtained, while on the other hand the eastern shad, transported to the west, has so reproduced and multiplied that specimens have been gathered from San Diego to Oregon, and his place among the food fishes of the west become a material and economical fact.

Of foreign fish introduced, the German carp has proved the most successful, and is to-day distributed and being successfully cultivated in nearly every state in the union. And so in experimenting, successes have more than balanced failures, and while many plans and theories are still tentative, or even questionable, still in its broadest generalization, fish propagation, as a great public benefit, has passed the experimental point, and become a fact of national importance.

2.—THE CANADIAN AND AMERICAN FISHERIES OF THE GREAT LAKES.

BY JOHN H. BISSELL.

One of the ways in which the Canadian treatment of the general subject of fisheries is valuable is the exact and useful knowledge which they obtain of the whole subject. This accurate knowledge of the fisheries is serviceable in many ways. For instance, it enables the Legislature to know its importance as a subject of legislation; it tallies from year to year the success or failure of the preservative measures; it points out distinctly the value of artificial propagation and the points at which natural sources of re-supply need re-inforcement by artificial and scientific methods. The Canadian reports show the total value of the fishery product of the Dominion, and also minutely the relative value of each item or variety of fish, as well as that for each province.

There is before me the Report on the Fisheries of Canada for the year 1883. On the first page is the statement that the product of 1883 was $134,100.64 more than for 1882 for the Dominion; the total valuation for 1883 being $16,958,192. Of course the greater part of this enormous production is of salt water fisheries, while the principal interest of dwellers along the great lakes is respecting the Canadian fresh-water fisheries—those of the province of Ontario. Before going into that, however, it will be interesting to look at the reports of 1884 and 1885, and compare the total production for those years with the total of 1882 and 1883. The figures are given as follows:

1882	$16,824,092 34
1883	16,958,192 98
1884	17,852,721 00
1885	17,722,973 18

There was a general increase for 1885 in all provinces except that of Nova Scotia, where there was a decrease of "nearly half a million in the item of mackerel alone."

Turning now to the province of Ontario we find the total value given for 1883 to be $1,027,032.88, an increase over 1882 of $201,575 86. The principal items in the order of their values are:

Salmon trout	$354,692 72
Whitefish	264.581 60
Herring and ciscos	97,070 00
Pickerel	82,096 38

The expenditure for "fishery service" for the entire Dominion for the year 1883 was no less than $114,673.76, and in 1884 was $116,531.66, of which the amounts for the province of Ontario were as follows:

Purpose.	1883.	1884.
Fishery officers, salaries and expenses	$13,602 00	$15,192 73
Fish-breeding	10,144 95	8,011 17
Total	$23,746 95	$23,203 90

The total expenditure for fish-breeding in the Dominion for 1883 was $25,776.87, and the amount for fishery officers was $62,341.43. The total value of the fish product of Ontario for 1884 was $1,133,724.26.

The number of men employed in this province as fishery officers in 1884 was 82, for a coast line no longer than that of the state of Michigan. This number of men, designated as "fishery officers," does not include the men employed in fish-breeding, but only those employed as inspectors, overseers, and wardens to enforce the fishery laws.

We desire to call particular attention to the figures for the year 1885, because that is the only year in which the Michigan fishery product has been accurately reported, and consequently the only season's fishing for which any reasonable comparison can be made between this state and the province of Ontario.

The total fish product of the province of Ontario for 1885 in value was $1,342,691.77, or a little over four and two-thirds cents per pound on the average.

	Pounds.
Whitefish	3,938,500
Trout	5,431,654
Herring	11,941,200
Muskallonge	565,400
Bass	636,397
Pickerel	1,757,494
Sturgeon	1,459,035
Pike	468,430
Other kinds, coarse fish and eels	2,578,908
Total	28,777,018

This statement includes 913,100 pounds of fish consumed at home by the fishermen and their families or by others, so as not to appear in the totals of the amount marketed.

During 1885 the expenditure for "fishery service" for the Dominion was $153,215.56; for fishery officers, $77,821.67; and for fish-breeding, $43,879.82.

For the province of Ontario, in 1885, there was expended—

For fishery officers, salaries and expenses	$17,135 98
For fish-breeding	8,690 15
Total	$25,826 13

It should be noticed that the figure $8,690.15 for fish breeding does not include the salary of the superintendent or office expenses. Further, it is for the maintenance of two fish-breeding establishments; one at Newcastle, for trout and salmon, and one at Sandwich for whitefish and pickerel. The state of Michigan maintains four establishments or hatcheries, the estimated

cost of which was $9,476. On the basis of these figures, the output of young fish is about 20,000,000 in excess of the Canadian hatchery product, while the excess of expenditure is only about $800. It should also be noticed that the expenditure in Michigan for all purposes connected with the fisheries was, for 1885, but $12,000 (not including permanent improvements), against the Canadian expense for the same year, for fish-breeding and care of the fisheries, $25,826.13, as given above.

The force of this comparison will be more fully appreciated from the figures given below, which show the product of Michigan fisheries to be about equal to those of Ontario in weight; and if the values are computed at the same rate as the Canadian, the total value will be about the same.

In the seventh Michigan report (1886) the catch of 1885, as there estimated, is 26,381,875 pounds. Adding to the amount allowed by the Canadian report for home consumption, not reported, 913,100 pounds, we have, as the total to be estimated, 27,294,975 pounds.

This, at the rate allowed in the Michigan report (three cents per pound), is equal to $818,849.25. But if taken as the Canadian product is, not by a general average, but at their figures for each species, the result will be as follows:

Michigan product, 1885.

Kind.	Pounds.	Price.	Value.
		Cents.	
Whitefish	9,985,015	7 1-5	$718,821 08
Trout	5,469,912	7½	410,235 90
Herring	5,249,384	2 2-5	126,510 15
Pickerel, bass, and sturgeon	1,530,161	5	76,508 05
Other kinds	5,060,603	3	151,818 09
Total	27,294,975	5 1-10	$1,483,893 27

Product of Michigan and Ontario, 1885.

	Pounds.	Value.
Michigan	27,294,975	$1,483,893 27
Ontario	28,777,018	1,342,691 77
Difference	1,482,043	$141,201 50

The excess of the Ontario product over that of Michigan is thus seen to be 1,482,043 pounds, while the value of the Michigan product is $141,201.50 above that of Ontario. This result is accounted for by the larger production of whitefish in Michigan waters, as shown by the following comparison:

	Pounds.	Value.
Michigan	9,985,015	$718,821 08
Ontario	3,938,500	282,950 00
	6,046,515	$435,871 08

Or if the Michigan product is figured at what is probably the exact Ontario average price, as their fish run, that is 4⅔ cents per pound, it is $1,271,945.83.

But, in view of the larger production of whitefish in the Michigan catch, it does not appear that the above comparison is at all unfair.

Taking the products of the two states as about equal in quantity and value, there is a very noticeable difference in the amounts expended by each in the care and conservation of this industry, as shown above. The coast line of each state is of the same length, about 2,000 miles.

Detroit, Mich., March, 1887.

3.—SOME EXPERIMENTS WITH THE FRY OF WHITEFISH.

BY DR. J. C. PARKER.

The question as to whether the young of the whitefish would find food and live when planted out of season much earlier than at the time at which they usually mature had been one of much discussion amongst those interested in fish-culture in Michigan, it being generally thought that while the lakes were filled with ice that the temperature of the water would be so low that there would be no organisms upon which the young fish could feed, and, consequently, starvation would ensue. To test this question Superintendent Marks directed the overseer, Mr. A. W. Marks, of Petoskey Station, of the Michigan Fish Commission, to institute certain experiments and to report the same to the board. The report is as follows:

On March 1, 1887, a small screen or crate made of wood and wire netting, three feet long and four and a half in diameter, in the form of a cylinder, was placed through the ice in Little Traverse Bay, in 100 feet of water, and 10,000 whitefish placed in the crate and lowered to the bottom with a strong rope. On March 5 the crate was raised and the young fry were nearly all alive, only six dead ones found. On March 10 the crate was raised again and twelve dead fish were found. The fry had turned to a light brown, the yolk sac was nearly absorbed and the fish seemed in good health. On March 12 the crate was again raised and some of the fry taken out and brought home; also a jug of water from the bottom and another from the top was taken. One drop of this was placed under a strong glass and life could be seen very plentiful. The stomach of one of the small fish and a drop of the water was placed under the glass and it was found to be full of diatoms and vegetable matter. The diatoms seemed to be working around the small pieces of vegetable matter; the sac of the fry had been absorbed and they were feeding upon the vegetable matter and the animalcule. On March 14 the crates were again lifted, and the fish seemed to be doing well in about the same condition as on the 12th. About 100 dead fish were found on the 14th. The crate was lifted on the 18th; no change could be seen. On the 24th the crate was again lifted, and some of the young had turned to a light green, the color of a herring a year old. On March 24 another crate was sunk, containing 5,000 fry. This was lifted on the 18th, and two dead fish were found in the crate. At this date the first crate sunk contained fish forty-five days old that had been under the ice twenty-eight days. About the last of March the ice moved out of the bay, thus preventing any further systematic observations. Later on the submerged crates were recovered, but the wire screens had become filled with sediment, caused by the roiling of the water consequent upon the breaking up of the ice, and no live fish were found in them This closed the experiments for that year, and circumstances prevented their continuance this spring.

Grand Rapids, Mich.

4.—SOME OBSERVATIONS ON THE BLACK BASS.

PAPER READ BY MR. C. F. HOLT AT THE 17TH ANNUAL MEETING OF THE AMERICAN FISHERIES SOCIETY.

Having resided for the past 35 years on the bank of the Thornapple river, a favorite resort for that king of Michigan game fish, the small-mouthed black bass, I have had ample opportunity for studying their habits, and for the past few years have given the matter considerable attention.

They leave their winter quarters, usually under heaps of drift-wood or in hollow, sunken logs, about the middle of April, and in a short time repair to their spawning grounds. I am quite sure that they pass the winter in hollow, sunken logs whenever they can, for, about the 1st of April, 1885, while removing some drift-wood from the river, we took out one hollow log that contained 18 small-mouth black bass, weighing from two to three pounds each; and again this year, at about the same time, I found six more under the same conditions. The spawning season here begins the last week in April. The first bed seen in 1885 was on April 28; in 1886, April 24; and in 1887 and 1888, April 26. The places selected are in nearly still water, near the shore, and in water from one to two feet in depth.

The beds are circular in form, from 18 inches to three feet in diameter, and are formed by cleaning from the bottom all sediment, sand, etc., leaving a bed of clean pebbles. This is the joint work of both male and female fish. The bed having been prepared, the female then moves slowly over it, depositing her ova, and the male impregnates them as fast as laid. The eggs, which are very small, are glued fast to the pebbles. The impregnation is almost absolutely perfect. In the past three years I have examined a large number of beds by carefully removing one or more of the pebbles covered with eggs, and examining them with a microscope, and have never yet found more than one per cent. of unimpregnated eggs.

After the eggs are impregnated the male leaves to the female the whole care of the eggs and the young brood. She now passes constantly backwards and forwards over the bed, the motion of her fin and tail keeping the eggs clean, which the fact of their being glued fast permits her to do without washing them away. The following incident will illustrate the necessity for this constant care and attention on the part of the female, as well as point a moral, and furnish an illustration of how the greatest possible increase of this fish may be brought about: One evening in the spring of 1886 I noticed a "jack light" coming down the river, and I felt certain that some of my pets would have to suffer. I had endeavored to protect them as much as possible by requesting such neighbors as I could reach to respect my wishes and to avoid the beds that I had under observation. Nearly all were willing to do so, but this time one of them made a mistake, as I expected they might, and when I

went out in the morning the mother fish was gone. I thought I would secure the young fish (they were just hatched) and take them to the house and "bring them up by hand." So, putting on my wading boots, I walked out to the bed, and there I found, not the young fry, but three or four crayfish and some minnows, which had evidently devoured every fish on the bed. At another time, under similar circumstances, except that the eggs were not hatched, the crayfish had destroyed all the eggs. I took up every pebble without finding a single one.

The eggs are hatched in from five to ten days, according to the temperature of the water. When first hatched, the young fish are transparent and so small as to be invisible to the naked eye. They have a much larger umbilical sac than the young brook trout in proportion to the size of the body. At first they are unable to swim or even move themselves from the bottom, but in from two to six weeks they begin to rise and swim, although they are from one to two months old before the sac wholly disappears and they become perfectly developed fish.

After the fish are hatched the mother seldom passes over the bed, as in their then helpless state the motion of her fins would scatter them; but instead she now swims in circles around it, driving away all intruders, such as minnows, crayfish, etc. After the young begin to swim she enlarges the circle until it becomes from ten to fifteen feet in diameter; she then gradually drives them towards the shore into shallow water, where she keeps them inside of a half circle, the shore forming the other side. From this half circle all of their natural enemies are carefully excluded, and the fish are allowed to develop. After that is done she scatters them along the shore among the weeds and grass, where, if pursued, they can find hiding places. Then, and only then, does she leave them to care for themselves. They are now from one-half to three-fourths of an inch in length, black in color, and very lively, darting out of their hiding places and seizing their prey as readily as the elder fish, and by the first of October following will be two inches in length.

I should estimate the average number of eggs in the beds at 4,000. Owing to the fact that some of the beds observed were near the mouths of cold spring brooks, where the temperature of the water in the river was much lower than where other beds were located, will account in a great measure, in my opinion, for the variation in the time taken for hatching the eggs and the development of the young fish; as in some seasons and in some locations I have found the young fish developed or weaned in one month from the time that the ova were deposited, and at other times two months were required for the same purpose.

I have been unable to procure both male and female fish at the proper time to try artificial impregnation, but have repeatedly taken part of the ova from the bed as soon as impregnated and hatched them in dishes, and have kept them there until fully developed. I am of the opinion that very little can be done in the way of artificial impregnation or hatching, as nature has done for the black bass all that could be done.

All that the fish-culturist needs to do is to stock all suitable waters with them, where they do not now exist, and then protect them during the spawning season.

5.—CO-OPERATION IN FISH-CULTURE.

BY JOHN H. BISSELL, OF THE MICHIGAN FISH COMMISSION.

Within the limits properly allowed for a paper in a meeting like this, it is scarcely possible to do more than sketch or outline a subject such as I have chosen. I am consoled, however, with the reflection that the manner and style will be passed with indulgence if only there be some merit in the subjects presented for consideration, or at least good faith on the part of the reader.

I think it is generally agreed, that fish-culture has passed its purely experimental stage. It is in fact fast becoming recognized as a practical art, and an established department of civil government, its definitely ascertained results, which are now unquestioned, fully warranting the recognition it has received from the states and the United States. Having so attained to the period when it is capable of being made a useful factor in the economy of every civilized state, the persons charged with the public duty of administering its affairs and evoking useful results from its prosecution ought ever to be looking for reasonable and practical ways to secure it the highest degree of efficiency. The United States Commission with a new and broader organic law recently adopted and put in operation, with its departments of work newly recast and systematized, and under most zealous and competent guidance, is prepared now to apply in the solution of some economic problems, the many lessons of experiment and scientific observation, gathered and stored up in the past. The states which have been dealing practically with the fishery question in the last ten years have made good progress towards reliable and permanent methods of fish-culture, and now at length are able to bring forward some definite and tangible proof concerning its results.

Fish-culture, when appreciated and invoked in both its branches, artificial propagation and legal regulation, has demonstrated its ability to restore exhausted fisheries. Of that there is no need of citing evidence to this audience. The next forward movement toward the realization of the great promises of the practical Art of Fish-culture, in this country is, I believe, to be the working out of a just and comprehensive system of regulation of fishing as an industry, and as a recreation. A notable feature of this movement will be the attainment of more substantial coöperation amongst the organized bodies existing for its prosecution under the state and federal government.

I have in mind two principal topics: 1. Coöperation between the United States Commission of Fish and Fisheries and the several State Fish Commissions; and, 2. The limited coöperation possible between the commissions of neighboring states, or between states having similar fishery interests. I am not unaware of the fact that the United States Fish Commission has heretofore coöperated with the state commissions. But I wish to call attention to the fact that such coöperation can be carried out on broader lines with advantage to all concerned.

You are all as familiar—perhaps many of you more so, than I—with the organizations employed in prosecuting fish-cultural work in this country, so that no detailed account of them is necessary. Here is the United States Fish Commission with men, with means, with appliances and with scientific knowledge, and while doing the same kinds of work that various state commissions are doing, yet doing much more than any single state organization. Here are the state commissions each prosecuting the particular kinds of work required by local conditions under which in the different states fish-culture is being carried on. At the points where these different organizations have work common to each, why may there not be cordial and effective co-operation? Not merely the negative, of not interfering with each other, but the positive working together to economize expenditures and effort, and thus increase general and permanent results.

Bordering the great lakes are six states having a population of about fourteeen millions of people. The fisheries of these great lakes, as their product enters into the general commerce of the country, cannot be regarded as the concern of the six states—they are of national importance. If the fish captured in these lakes were consumed along their shores I grant that the states would have no special claim upon the general government for taking part in maintaining such fisheries, or helping in any way to their re-establishment. This was the condition of affairs once; but with the modern facilities of rapid communication and improved methods of transportation, their product is marketed all over the country, and for that reason the states bordering the great lakes have, in my judgment, as good a right to assistance from the general government, in the directions I shall presently mention, as the fisheries of the Atlantic and Pacific Oceans. Our lake fisheries are not to be compared in extent and value to those of the seas, but it is a difference in degree not in kind. The United States is doing a most necessary work in the investigation and promotion of the Atlantic fisheries, is preparing to investigate more thoroughly, and help develop the fisheries of the Pacific; it has done the country an invaluable service in examining and illustrating the seal and other fisheries in connection with the last general census; for all of which it has earned the confidence and commendation of the country. Why should not a similar service be performed by it in co-operation with the states bordering the great lakes in making an exhaustive survey and examination of the fisheries from Duluth to the St. Lawrence river? "The reward of having wrought well is to have more work to do." If the commission has not the equipment in steamers, the work already in hand probably requiring them all, why not borrow one or more of the revenue cutters that are lounging up and down the lakes? I may be doing that branch of the service an injustice, but I never have heard within ten years of those vessels doing anything more useful than cruise on a sort of dress-parade between Buffalo and Chicago.

If a revenue cutter could not be spared, then why not borrow from the Navy Department a despatch-boat, or some of the many steamers not suitable for modern naval warfare, and have her fitted out for this service. To do what? To be manned with the necessary crew, under command of an officer not above such service, placed under the direction of the United States Fish Commission, supplied by him with one or more naturalists, and one or more men competent to study and report upon the conditions, capacities and needs of the industrial fisheries, supplied with drags, sounding appliances, proper thermometers, duplicate charts of the lakes, and complete fishing apparatus. Upon the charts could be marked spawning-beds, seining grounds, the lines of inshore and outside fishing, abandoned fishing grounds, the lines where certain kinds of fish are most plentiful or scarce, the pound-net fishing stations and the like. With such an equipment it would be practicable to make a complete survey of the fishing, feeding and spawning grounds of the great lakes; exhaustive scientific observations and collections of the fauna; a census of the fishing industry, its methods, its product, its habits; in fact, a history that would, by its manifold and exact observations of the present condition and requirements of the industry and its possibilities, lead conclusively to a knowledge of the causes of its decadence, and what is necessary to be done for its restoration and permanent maintenance. Is it worth the expenditure? I think I can answer without hesitation for Michigan waters. I had occasion in 1886 to examine the history of Michigan fisheries, and was led to the conclusion, after careful examinations and comparisons of such statistics as are obtainable, that if our waters had been as productive in 1885 as they were in 1859, with the effectiveness of apparatus and extent of operations in the former year, the money value of the products of Michigan waters in 1885 would have been not less than fifteen millions of dollars, instead of about one and one-half millions. In 1887 I compared the product of the Michigan fisheries for the year 1885 with those of the Province of Ontario, and found that the money value of the former, if computed upon the same basis as that employed by the Canadian Department of Marine and Fisheries, exceeded that of the Province by more than $100,000.

The states bordering the great lakes having an immediate interest to be subserved by such an examination, as the work is being prosecuted in their waters, should co-operate by furnishing a crew of three or four men to assist in gathering statistics and other information, which would be of great value to the State Fish Commissions in illustrating to the Legislatures the kinds of regulations required to restrain wasteful fishing, which has gone so far towards depleting the waters, as well as the kind and extent of operations to restore productiveness of the waters. They might also direct or assist in the fishing operations of the expedition. Such an examination would also demonstrate the exact extent to which artificial propagation of whitefish benefited the fisheries, and indicate what points along the lakes required attention in order to the more even distribution of future supplies. The information so gathered would help, by furnishing the required data, towards another and most important feature in the regulation of the fisheries of the great lakes, namely, the licensing of fishing as an industry. In alluding thus briefly to this subject there is not time to more than call attention to the fact that a fair system of licensing would in time defray all or the larger part of the expenses of keeping up the supplies of fish when the waters were once well stocked, as well as such part of the cost of enforcing the laws as the state

would be called on to pay. There are several minor ways in which co-operation can be advantageously adopted, but not of sufficient importance to be enumerated here. They are being employed more or less, and are familiar to you all.

For many years the U. S. Commission has thus co-operated with two or three of the New England States in procuring salmon and Schoodic salmon eggs, on terms, I believe, equitable and satisfactory to all parties, and with most excellent results.

Another direction in which co-operation can, I believe, be advantageously employed is in a thorough examination of interior lakes. By interior, or inland, lakes the dwellers along the great lakes are wont to distinguish the smaller bodies of water wholly within the boundaries of the several states. In Michigan, the numbers, size, and natural conditions of the inland lakes make them a considerable part of the waters we are called upon to care for. In the earlier days of this work these lakes were planted with various kinds of fishes, not with any special reference to their adaptability to the fish planted, but because the commission had fish for that purpose, and in a general way the people in the vicinity of the lakes wanted fish. I do not say this with the design of casting any reflection upon the authorities of those days. The promiscuous planting of fish was then perfectly natural; and our experience is based largely upon their mistakes as it is still more largely upon the notable success of so many of their experiments. As the years went by a very natural curiosity arose amongst citizens and fishery authorities to know what had been the result of those plants. Had all failed? If so, why? If the fish planted had not lived and prospered, would no others live in those waters? And, finally, the question formulated itself, are these waters suitable for any fish? If so, what kinds? There was but one way to answer these questions, and that was to go and find out. And so we went (by proxy). In 1885 in a desultory kind of a way the work of examining the lakes was begun. In 1886 a proper crew was organized, consisting of three men, one being in charge. They were provided with a gang of gill-nets having meshes of four different sizes, thermometers, a small drag or trawl, sounding lines, fishing tackle, blank reports with printed instructions, and a complete camping outfit. And so with fairly good and practical results the lakes of three counties on the southern border of the state were examined and reported on. For a short time towards the end of summer a second crew was sent out to examine some places where there were special reasons for knowing the contents and capabilities of several lakes. In 1887 further improvements were made in the outfit, and the crew increased to four. The addition of one man secured more expeditious work. The result of these examinations give the Michigan Commission in permanent and convenient form, not only the exact, but the essential facts about the lakes in eight counties of this state. The size, depth, character of bottom, quality of water, temperature, inhabitants, kinds and quantities of food; in a word what fish are there, and the knowledge of what can and ought to be there in order to obtain the greatest productiveness of the given waters.

One characteristic these examinations have lacked. They afford an opportunity for scientific investigation, which would add materially to their practical utility, and which would certainly make them more complete from all points of view. We have not the means to supply that want. The United States Fish Commission has the means and the men. We are discussing with

the commissioner, and the head of the Department of Scientific Research of the United States Fish Commission, a practical method of co-operation in carrying on further examinations of Michigan lakes. Here is a field well worth cultivating. If fish-culturists are to do anything for the interior lakes they must know as well as possible the conditions under which their efforts must be used. There are six or seven northern states besides Michigan, of which I have some knowledge, where such efforts ought to be made.

And while the lakes are being examined, why not the streams and rivers? Our experience has proved that there are hundreds of spring brooks in this state suitable for the growth of speckled trout where that fish was not native. A systematic examination of all streams would in this state within a few years secure the planting of trout only in waters entirely adapted in temperature and good supply to trout. It would in my judgment also result in our being able to establish black bass in miles of water suitable for that admirable game and food fish where now they are unknown. Definite and comprehensive knowledge of the rivers and streams of the state, put into the same permanent and accessible form as the reports Michigan is getting of the lakes, is of importance just as the work on the lakes is.

Secondly, what co-operation can there be between State Fish Commissions? The most obvious points for co-operation between states, are where they border the same waters, as on the great lakes, or have a common boundary on a river,—as the Ohio, Mississippi, or Missouri. And here we must touch upon the regulation of fisheries, a subject pregnant with difficulties. For the states bordering the great lakes a uniform system for every mile of the great waters ought to be established. Not necessarily identical enactments; for the waters of a single state, like Michigan, require a diversity in regulations to make complete for all its waters the operation of a general system. The objects to be sought by each state are the same, the means to reach those objects will necessarily be somewhat modified by local conditions. From our own experience, I assume that it is a difficult thing to secure the passage of suitable laws by the State Legislatures for the preservation of commercial fisheries. We have no difficulty in obtaining fairly good laws for the protection of game fish; but we have tried in vain thus far to persuade the Legislature of this state to do for the fisheries of the great lakes what must be apparent to any man of common sense, who gives the subject any attention, is essential to preserve them.

I think the common judgment of men, who are entirely disinterested but careful observers of the past and present condition of our fisheries, accords with that which is always expressed by the most intelligent and candid of practical fishermen and fish dealers, to the effect that our laws should cover three vital points:

1st. To regulate the size of the meshes of nets, the times and places of fishing.

2d. The market size of the various valuable kinds of fish.

3d. The employment and authorization of competent state officers to enforce the regulations and inspect the products being marketed; and there should be confided to the chief officer discretionary power to suspend, within prescribed limits, the regulation respecting the apparatus, where such suspension will not result in the destruction of immature fish, and may be an advantage to the fishermen.

Regulations should be as general, as exact and as simple as is compatible

with efficacy, in order that they may not be oppressive or obnoxious. Of course, each state must enact its own laws. Each state has exclusive jurisdiction of its waters to its boundary line; this on the great lakes is a matter of great importance. It has many times been suggested by persons who had not examined thoroughly the question of jurisdiction, that Congress could better provide for the regulation of the fisheries of the great lakes, because these waters bordered on many different states. This question has been settled once for all by the Supreme Court of the United States, so that whatever of advantage federal legislation on this subject may seem to offer, it is a legal and constitutional impossibility, and must be dismissed. The states must do all there is to be done, and do it in their own several ways. Thus far it has been badly done,—or to speak more accurately, has not been done at all. Can there be any co-operation between the states to remedy this evil? There ought to be, is plain. And the fact of the recognized necessity ought to bring about, eventually, an affirmative answer. The force of a substantial and efficient example is the only constraint that can be brought to bear. When any one of the states bordering the great lakes will enact laws that are effective, its example will be followed.

Full and candid discussion between the fishery officers of the different states will be useful, and ought to be employed more frequently than in the past, for the purpose of harmonizing the views of all. By fishery officers I do not mean alone the fish commissioners, but include the wardens or officers employed to enforce the laws, by whatever names they may be known. And I believe that good results might be obtained from conferences between the fishery committees of the Legislatures of Michigan and Ohio, and Michigan and Wisconsin, and Ohio, Pennsylvania and New York. At least this is worth a consideration.

A step in the right direction was taken by Michigan, in 1887, in the passage of an act for the appointment of a Game and Fish Warden. The act was not as broad nor the powers as extensive as the commissioners urged upon the Legislature; but it was one point gained. The thorough, consistent and intelligent course pursued by the gentleman selected by the Governor as the State warden will go far towards securing at another session of our Legislature the required improvements in the law, as it has already demonstrated the important advantages of the proper enforcement of such laws as we have. Wisconsin took the lead in this class of legislation, but from all that I have learned of its operation, I judge that the statute needs amendments in some important points to make it effective. Ohio, too, has started in the right direction. This is all encouraging, because in each case it has been a movement in the right direction.

The fisheries, in my judgment, have reached a point where no half-measure will answer. What is needed is to limit the operation of the laws expressly to the best and practicable wholesome and sufficient remedies, that will put a stop to the destruction and marketing of immature fish of all valuable kinds; and while it gives nature a chance to help repair the mischief already done, will likewise help to secure to the states the benefits of the artificial propagation and planting.

A third suggestion in the line of conservation that I think worthy of discussion is between the fish commissioners and the educational institutions of the state—as for instance, with the instructors in natural history in the State University, or the Agricultural College. There are many ways in

which the two could aid each other. The University or Agricultural College, or both, might furnish the naturalists to accompany a crew of fish commission men in examining interior lakes and streams. They might do a notable service by furnishing a naturalist, who is expert with the microscope, to be present with our crews employed in gathering ova of different fishes; and by a critical study of ova and milt during the spawning time, instruct the men as to the appearance of the perfectly matured male and female properties, so as to bring such operations still nearer to perfection. At the same time, facts so acquired might be an actual and useful contribution to scientific knowledge. I am indebted to Mr. Marks, the Michigan Superintendent, for this proposal to improve the already good results attained in artificial fertilization.

Detroit, May 16, 1888.

6.—NOTES ON THE FOOD OF THE FISHES OF THE MISSISSIPPI VALLEY.

BY PROF. S. A. FORBES.

There is a kind of insect in the South, called the agricultural ant, which is extremely fond of the seeds of certain grasses growing there spontaneously among the many species which make the prairie sod. Naturally, the agricultural methods of this ant are of a very primitive sort, and even fall below those of the native Indian. Besides collecting, wherever it can find them, the fallen seeds of many grasses and other plants, and storing these in its burrows, it also clears completely an area from six to twelve feet wide around its nest, and here either sows or permits to grow only one or two of the common grasses of whose seeds it is especially fond, harvesting the product and storing it for future use. It has not learned to cultivate the soil, or to introduce exotic plants of larger yield and better quality than those native to the sod, but it has advanced so far as to destroy on a little tract the competitors of the plants which bear its favorite food, and thus secures a large and more convenient supply than would grow spontaneously. I mention this little ant because its agriculture seems to me to illustrate very well the aquaculture practiced by mankind at the present time. As this little insect collects the seeds of weeds wherever they happen to grow, so we fish the streams for whatever they happen to contain; and as it clears its little farm around its burrow, so we make our little fish ponds, seine out the worthless and destructive fishes, the snakes, frogs, and turtles, and throw the better species back to increase for our benefit. In two things our aquaculture is in advance of the agriculture of the ants,—we have successfully introduced two or three foreign species, and we have learned to take measures to maintain the fish supply wherever it has suffered from the effects of overpopulation. The first of these measures the ants have not thought of, and the second they probably do not need, because their numbers do not overrun their food supply. I believe it will pay us to inquire whether we can hope to get beyond this ant stage of aquaculture, and whether we may not learn to do at least as much to increase and improve the product of the waters of the country as the wild Indian did to cultivate the soil.

At present, four things are done, in general: First, we attempt to maintain or restore the relative numbers of our valuable aquatic animals—fish especially—defending the population of our waters against the evils growing out of civilized settlements. This is like trying to restore the native growth of trees and grasses to the surfaces deadened by travel and building, and by

careless or unskillful usage. Second, we try to increase the relative numbers of the most valuable of our native aquatic animals above the limit fixed originally by nature. This is as if we should collect and plant the nuts and acorns in the woods, and gather and sow abroad the seeds of the most valuable native grasses, in the hope that this artificial aid might enable our favorites to surpass their rivals. Third, we have aimed to introduce foreign with our native species in our natural waters. This is too much like sowing quantities of apple seeds and wheat and corn broadcast in the woods and on the prairies in the hope that if we use seed enough the plants we seek to introduce will crowd out the native vegetation. And, finally, we do, on a small scale, partly imitate actual agriculture by clearing or forming little patches of water here and there, and planting in them an exotic fish, protecting it from the competition of the native species. Here we approach the agricultural practice of the native Indian, who partly cleared his little patches in the river bottoms and planted and harvested the exotic corn and beans and pumpkins.

But it will not do to push this parallel too far. There are some things possible in agriculture which the aquaculturist cannot do. We cannot plow and till our lakes and rivers as the farmer does the prairie sod, ruthlessly exterminating all the native forms of life in order to substitute other sorts more useful to him. And even where we clear a little lake or start a pond, stocking it with carp or croppie, we cannot keep out the frogs and bullheads by any artificial tillage, as the farmer can the weeds. We are compelled, in other words, to work for improvement in the midst of things as they are. Not being able to destroy the native population of our waters, we have to take it into account and then make our adjustments to it. And right here, it has long seemed to me, is where the work is most needed. If we cannot get rid of the natural order we certainly need to understand it. If we cannot destroy the native population, but must live and work with and through it, we certainly ought to know what it is like and what we can do with it; what we can do in spite of it, and what we cannot do because of it. It is because I have worked out some parts of an answer to these questions that I have ventured to appear here to-day, in a society of fish-culturists. If fish-culture is merely the culture of fishes, then I can have little or nothing to say, because I never raised a fish in my life; but if a scientific and rational fish-culture must finally merge in the broader science and art of aquaculture; if we must study to understand and improve the system of aquatic life into the midst of which we thrust our little fishes,—then I may perhaps claim some share in your deliberations.

What I have to report to-day is chiefly an answer to the question: What do our native fishes eat? This is only a single item of what we really need to know, and yet perhaps a larger one than might at first be supposed. Although fishes are the dominant class in every fairly permanent body of fresh water, they have no great variety of interests or occupations; but except for the relatively brief intervals devoted to their simple office of reproduction, they do little but to search for food and to eat, and avoid being eaten in turn; consequently, if we seek to measure or estimate their function in the general system of life in any region or locality, we are limited chiefly to their food relations, immediate and remote.

Among the purely practical results to be anticipated from such a study, are a more accurate knowledge of the conditions favorable to the growth and multiplication of the more important species; the ability to judge intelligently

of the fitness of any body of water to sustain a greater number or a more profitable assemblage of fishes than those occurring there spontaneously; guidance as to the new elements of food and circumstance which it will be necessary to supply to insure the successful introduction into any lake or stream of a fish not native there; and a clear recognition of the fact that intelligent fish-culture must take into account the necessities of the species whose increase is desired, through all ages and all stages of their growth, at every season of the year, and under all varieties of condition likely to arise.

We should derive, in short, from these and similar researches, a body of full, precise, and significant knowledge to take the place of the guess-work and empiricism upon which we must otherwise depend as the basis of our efforts to maintain and increase the supply of food and the incitement to healthful recreation afforded by the waters of the country.

As a contribution to the general subject, I present herewith a summary account of the food of twelve hundred and fifteen fishes, obtained from the waters of the state of Illinois at intervals from 1876 to 1887, and in various months from April to November. These fishes belonged to eighty-seven species of sixty-three genera and twenty-five families. They were taken from waters of every description, ranging from Lake Michigan to weedy, stagnant ponds and temporary pools, and from the Mississippi and Ohio rivers to the muddy prairie creeks, and the rocky rivulets of the hilly portions of the state. Nine hundred and fourteen of the examples studied were practically adult, so far as the purposes of this investigation are concerned, the remaining three hundred and one being young, in the first stage of their food and feeding habits. More than half these young belonged to a single species—the common lake whitefish—but the remainder were well distributed.

I have arranged the matter under the following general heads: (1) a general account of the food of the most important species and families of our native adult fishes; (2) a brief account of the food of the young; and (3) a summary statement of the food, so made as to exhibit (*a*) the kinds and relative importance of the principal competitions among fishes, and (*b*) the relative value to the principal species of fishes of the major elements of their food.

First, then, I will attempt to give you very briefly, and in the most general way, the facts relating to the food of the most important fishes, those which I think most likely to interest you as fish-culturists, taking the species in their zoölogical order rather than in the order of their economic importance.

FOOD OF ADULTS.

The abundant white perch or sheephead of the larger rivers and lakes, now commonly marketed, I find feeding, when full grown, almost exclusively upon the bivalve mollusks known in the west as clams, whose heavy shells this fish is enabled to crush and grind by a special apparatus in the throat. The shells are swallowed with the bodies and pass, in part at least, through the intestine. Half-grown specimens feed in much larger ratio upon aquatic insects, especially the larvæ of May flies, but take likewise the smaller mollusks with spiral shells, commonly known as water snails, the food in my examples being about equally divided between these two elements. The youngest specimens feed, like the young of fishes in general, upon the smallest of the crustacea.

The common perch or "ring perch," excessively abundant throughout the northern part of the country, varies in food according to the waters it inhabits, those in the great lakes feeding almost wholly upon small fishes (especially of the minnow family), and upon crayfishes—five or six times as many of the former as of the latter. River specimens, however, eat few fishes, but they find nearly half their food among the crustacea, partly crayfishes, but chiefly the smaller kinds, known to zoölogists as amphipods and isopods, and in common speech as water-lice and brook shrimps. Aquatic insect larvæ, especially those of day-flies, and small spiral-shelled mollusks are eaten in about equal ratio.

The two pike-perch or "wall-eyed pike," are exclusively piscivorous, if we may judge from twenty-six specimens whose food I studied. More than a fourth of the fishes taken consisted of the spiny-finned species, including eight per cent. of catfishes, but nearly half were the common gizzard shad.

We shall find accumulating evidence that this shad, not used with us for food, is, notwithstanding, one of the most valuable fishes in our streams. Nevertheless, not the slightest attention is paid to its preservation, much less to its encouragement. The fishermen commonly regard these fishes as a mere nuisance, and leave them to die on the bank by hundreds, rather than take the trouble to return them to the water. They are a very delicate species, and are easily killed by rough handling in the seine, but the majority of those captured might be saved with a little care.

Their abundance as compared with some other species in our rivers might seem to indicate that they are common enough as it is Few realize, however, the number of fishes needed to feed a pike-perch to maturity. Two or three items from my notes will furnish the basis for an intelligent estimate.

From the stomach of a pike-perch caught in Peoria lake, October 27, 1878, I took ten well-preserved specimens of gizzard shad, each from three to four inches long; and from another I took seven of the same species, none under four inches in length. As the gizzard is a very thin, high fish, with a serrate belly, these were as large as a pike-perch can well swallow; and we may safely suppose that not less than five of this shad would make a full meal for that fish. The pike-perch is a very active hunter, and it is not at all probable that one can live and thrive on less than three such meals a week. The specimens above mentioned were taken in cold autumn weather, when most other fishes were eating but little; but since fishes generally take relatively little food in winter, we will suppose that the pike-perch eats, during the year, on an average, at this rate per week for forty weeks, giving us a total *per annum* of six hundred gizzard shad destroyed by one pike-perch. We cannot reckon the average life of a pike-perch at less than three years, and it is probably nearer five. The smallest estimate we can reasonably make of the food of each pike-perch would therefore be somewhere between eighteen hundred and three thousand fishes like the gizzard shad. A hundred pike-perch, such as should be taken each year along a few miles of a river like the Illinois, would therefore require from one hundred and eighty thousand to three hundred thousand fishes for their food. Finally, when we take into account the fact that a number of other species also prey upon the gizzard shad, and that the whole number destroyed in all ways must not exceed the mere surplus reproduced—otherwise the species would soon be extinguished—we can form an approximate idea of the multitudes in which the food species must abound if we would support any great number of

predaceous fishes. The gizzard shad, being a mud-eater and a vegetarian, taking little animal food except when very young, can probably be more readily maintained in large numbers in our muddy streams than any other fish.

The two species of black bass differ, according to my observations, in the character of their food, the large-mouthed species eating more fishes and the small-mouthed more crayfishes. Here, also, the gizzard shad made more than half the food.

The common sunfishes are readily divisible into four groups, based on their feeding structures and their food; one characterized especially by the wide mouth, including the black warrior and the blue-checked sunfish, took a noticeable amount of fishes, the ratio varying from a third to a half, the remainder of the food being chiefly insects, crayfishes and smaller crustaceans. Those with small mouths, pointed teeth in the throat, and short gill-rakers, like the most abundant of the river species, took scarcely any fishes, but fed chiefly on insects and crustaceans, the latter principally the forms of medium size (amphipods and isopods). Some of this group likewise took a large amount of vegetation, amounting to a third or fourth of the whole.

A group with small mouths and blunt conical teeth in the throat, illustrated by the common bream or pumpkin seed, was distinguished especially by the number of small snail-like mollusks eaten, these making, in my specimens, more than a third of the food. The remainder was chiefly aquatic insect larvæ, the medium-sized crustacea and water plants.

The fourth group, illustrated by the croppies, have the mouth long but narrow, and the gill-rakers numerous and long. By these a few fishes are taken, but the food is chiefly insects and the smallest crustaceans—those commonly referred to as entomostraca, a food resource which they are enabled to draw upon by the straining apparatus in the gills.

Passing to the pike or pickerel of our Western rivers, I find that the common large river pike, *Esox lucius*, is almost wholly pisciverous, a single specimen only out of the thirty-seven examined, having taken a number of dragon flies. About a fifth of the fishes were sunfishes (half of them croppies) and black bass. Twenty of these thirty-seven pike had taken gizzard shad, which made, in fact, nearly half of the food of the entire group. Minnows were found in only two, and three had eaten buffalo fish.

The striking features of this record are the importance of the gizzard shad, the abundance of the spiny-finned fishes, including some of the most valuable kinds, and the insignificant number of minnows and suckers taken.

The grass pickerel, a species which rarely reaches a foot in length, had eaten tadpoles of frogs, and fishes and insects, the latter making more than a third of the food, and consisting chiefly of the larvæ of dragon flies.

The gizzard shad, mentioned above as an especially valuable element of the food of the higher fishes, feeds itself almost wholly upon mud, with which the long and coiled intestine of every specimen was filled from end to end. This mud contained, on an average, about twenty per cent. of minute vegetable *debris*, with occasionally a little animal matter.

The great minnow family I can scarcely pass by, since it contributes so largely to the food of other fishes, although itself of little or no direct advantage to mankind. I found this family dividing into several groups based upon the length of the intestine and the form of the pharyngeal teeth. In the first of these groups, containing several of the more abundant sorts,

about three-fourths of the food consisted of soft black mud, the remainder being both animal and vegetable matter, chiefly the latter. These fishes all had very long intestines and smooth grinding teeth in the throat. In another group quantities of mud are also taken, but with it many *Entomostraca*, while in groups three and four, containing by far the greater portion of the family, the food is essentially different, about three-fourths of it being insects and small crustaceans, and the remainder vegetation. I note especially here the value of the mud-eating minnows as food for larger fishes, since while abundant and easily maintained, they do not compete with the young of the larger fishes to whose sustenance they may be applied.

One of the most striking characteristics of the fish-fauna of the Mississippi valley is the prominence of the sucker family, several of which are among the most abundant of our larger fishes. About one-tenth the food of this family, taken as a whole, consisted of vegetation, eaten chiefly by the buffalo fishes, and in them composed largely of distillery slops. The family is, however, essentially carnivorous, mollusks and insects appearing in nearly equal ratio in the food. The former are taken much the more generally by the cylindrical suckers, and the latter about equally by all except the stone roller, which collects great quantities of insect food by pushing about the stones in running water. A large proportion of the insects eaten are small larvæ of gnats (*Chironomus*). Some of the deeper-bodied species with long gill-rakers, especially the river carp, feed largely on *Entomostraca*, this latter species swallowing also considerable quantities of mud.

The catfishes, taken together, are nearly omnivorous in habit, and their feeding structures have a correspondingly general character. The capacious mouth, wide gullet, and short, broad stomach admit objects of large size and nearly every shape. The jaws, each armed with a broad pad of fine, sharp teeth, are well calculated to grasp and hold soft bodies as well as hard. The gill-rakers are of average number and development, and crushing jaws in the throat, broad, stout arches below, and oval pads above, covered with minute pointed teeth, serve fairly well to break the crusts of insects and the shells of the smaller mollusks, and to squeeze and grind the vegetable objects which occur in the food. The most peculiar feeding habit relates to the larger bivalve mollusks, the bodies of which are frequently found almost entire in the stomachs of these fishes and always without a fragment of a shell. I have been repeatedly assured by fishermen that the catfish seizes the foot of the mollusk while the latter is extended from the shell, and tears the animal loose by vigorously jerking and rubbing it about. One intelligent fisherman informed me that he was often first notified of the presence of catfishes in his seine, in making a haul, by seeing the fragments of clams floating on the surface, disgorged by the struggling captives. Finally, these are the only habitual scavengers among our common fishes. The larger deep-water species from the great rivers are strictly piscivorous, so far as known. Very small stonecats feed on the smaller insect larvæ and the medium-sized crustacea. The spotted cat, blue Fulton, or fiddler, feeds largely on mollusks, but is, nevertheless, chiefly insectivorous. It differs from most of the river catfishes by eating water-plants to a considerable extent. The common bullhead is more strictly omnivorous than any other kind, its food being composed about equally of fishes, mollusks, aquatic insects, and vegetable structures, with a very considerable ratio of crustaceans added. The great mud-cat, or Morgan cat, reaching a weight of over one hundred pounds, seems to feed entirely upon fishes.

The abundant and peculiar dogfish, or "grindle," is strictly carnivorous, about one-third of the food being fishes, a fourth of it small mollusks, and nearly half crustaceans, chiefly crayfish.

The gars are all strictly piscivorous, feeding especially upon the gizzard shad.

The most remarkable of our fishes, in structure and feeding habit, is the shovel-fish, or "spoonbill," of the Mississippi and its larger tributaries. It is a large species, reaching a weight of thirty pounds and upwards and a length of six feet or more, including the paddle-like snout. Although so large, the greater part of its food consists of the smallest aquatic Crustacea and insect larvæ, strained from the water by means of an extraordinary apparatus in the gills, composed of long and slender gill-rakers, a double series on each arch, and over five hundred in a series. Interlocking as these do when the gill apparatus is extended, they form a strainer sufficient to arrest the smallest living forms above the Protozoa, and with the immense opening of the mouth and equally free provision for the exit of water from the gill chamber, enable this fish to strain out enormous quantities of these minute animal forms, especially those most commonly reserved for young fishes. It takes also, in midsummer, insect larvæ of medium size, but evidently avoids vegetation, and never swallows mud.

FOOD OF THE YOUNG.

By an examination of three hundred and one specimens, representing twenty-seven species, twenty-six genera and twelve families of Illinois fishes, I learn that the food of many species of fishes differs greatly according to age; and that, in fact, the life of most of our fishes divides into at least two periods, and that of many into three, with respect to the kinds of food chiefly taken. Further, in the first of these periods a remarkable similarity of food was noticed among species whose later feeding habits are widely different. The full-grown black bass, for example, feeds principally of fishes and crayfishes, the sheepshead on mollusks, and the gizzard shad on mud and Algæ, while the catfishes are nearly omnivorous; yet all these agree so closely in food when very small, that one could not possibly tell from the contents of the stomachs which group he was dealing with.

In the earliest stage, all the fishes studied, except suckers and minnows, depend for food on the smallest crustaceans, commonly called Entomostraca, and on certain small worm-like larvæ of gnats or gnat-like flies scarcely larger than these crustaceans, and usually occurring with them. By far the most abundant of these insect larvæ was that known as Chironomus. The suckers and minnows differ from our other fishes by being toothless while very young, as well as when adult, while our other toothless fishes, gizzard shad, whitefish, etc., have in youth a set of evanescent teeth. These toothless young I found feeding in part on still smaller prey than the others, taking the smallest animal forms (wheel animalcules), various Protozoa, and Algæ so minute that the whole plant consists of a single vegetable cell. The food of the whitefish fry was determined by keeping several hundred of them in a large aquarium kept constantly supplied with all the living objects which a fine gauze net would separate from the waters of Lake Michigan.*

While small fishes of all sorts are evidently competitors for food, this com-

*See note following this paper.

petition is relieved to some extent by differences of breeding season, the species dropping in successively to the banquet, some commencing in very early spring, or even, like the whitefish, depositing their eggs in fall, that their young may be the first at the board, while others delay until June or July. The most active breeding period coincides, however, with that of the greatest evolution of *Entomostraca* in the back-waters of our streams; that is, the early spring. That large adult fishes with fine and numerous rakers on the gills—like the shovel fish and the river carp—many compete directly with the young of all other species, and tend to keep their numbers down by diminishing their food supply—especially in times of scarcity—is very probable, but is not certainly true as a general thing; for these larger fishes have other food resources, also, and many resort to Entomostraca only when these are superabundant, thus appropriating the mere excess above what are required for the young of other groups. Of the fishes which emerge from this earliest stage through increase in size with failure to develop alimentary structures especially fitted to the appropriation of minute animal forms, some become mud-eaters, like the *Campostoma* and the gizzard shad; a few apparently become vegetarians at once; but most pass into or through an insectivorous stage. After this a few become nearly omnivorous, like the bullhead; others learn to depend chiefly on molluscan food—the sheepshead and the red horse species; but many become essentially carnivorous. In fact, unless the gars are an exception, as they now seem to be (attacking young fishes almost as soon as they can swallow), all our specially carnivorous fishes make a progress of three steps, marked, respectively, by the predominance of Entomostraca, insects, and fishes in their food; and the same is true of those strictly fitted for a molluscan diet.

PRINCIPAL ELEMENTS OF THE FOOD.

An analysis of the facts made with reference to the kinds of fishes eating each of the principal articles in the dietary of the class, and showing the relative importance of these elements in the food of the various species, will have its separate interest for us, especially as it will exhibit the competition of fishes for food, and also the nature and the energy of the restraints imposed by fishes on the multiplication of their principal food species.

The principal fish-eaters among our fishes—those whose average food in the adult stage consists of seventy-five per cent., or more, of fishes—are the burbot, the pike-perch or wall-eyed pike, the common pike or pickerel, the large-mouthed black bass, the channel-cat, the mud-cat and the gars. Possibly, also, the golden shad will be found strictly ichthyophagous, this being the case with the four specimens which I studied. Those which take fishes in considerable but moderate amount—the ratios ranging in my specimens from twenty-five to sixty-five per cent.—are the war-mouth (*Chænobryttus*), the blue-cheeked sunfish, the grass pickerel, the dog-fish, the spotted cat and the small miller's thumb. The white and the striped bass, the common perch, the remaining sunfishes (those with smaller mouths), the rock bass and the croppie take but few fishes, these making, according to my observations, not less than five nor more than twenty-five per cent. of their food. Those which never capture living fishes, or, at most, to a merely trivial extent, are the white perch or sheepshead, the gizzard shad, the suckers and the shovel fish among the larger species; and the darters, the brook silver-

sides, the stickleback, the mud minnows, the top minnows, the stone-cats and the common minnows generally among the smaller kinds. Our eight specimens of the toothed herring had taken no fishes whatever; while our nineteen examples of the pirate perch had eaten only two per cent.

Rough-scaled fishes with spiny fins were eaten by the miller's thumb, the common pike, the wall-eyed pike, the large-mouthed black bass, the croppies, the dog-fish, the common perch, the burbot, the bullhead, the common sunfish (*Lepomis pallidus*), the small-mouthed black bass, the grass pickerel, the gar and the mud-cat (*Leptops*). Among these, the common perch and the sunfishes were most frequently taken—doubtless owing to their greater relative abundance—the perch occurring in the food of the burbot, the large-mouthed black bass and the bullhead; and the sunfishes in both species of wall-eyed pike, the common pike, the gars, pickerel, bullheads and mud-cat. Black bass were taken from the common pike (*Esox*), the wall-eyed pike (*Stizostedion*) and the gar. Croppie and rock bass I recognized only in the pike. Even the catfishes with their stout, sharp and poisoned spines were more frequently eaten than would have been expected—taken, according to my notes, by the wall-eyed pike, both black bass, and a fellow species of the family, the *goujon* or mud-cat.

The soft-finned fishes were not very much more abundant, on the whole, in the stomachs of other species, than those with ctenoid scales, spiny fins and other defensive structures, an unexpected circumstance which I cannot at present explain, because I do not know whether it expresses a normal and fixed relation, or whether it may not be due to human interference.

Only the catfishes seem to have acquired defensive structures equal to their protection, the predatory apparatus of the carnivorous fishes having otherwise outrun in development the protective armor of the best-defended species.

Among the soft-finned species the most valuable as food for other fish is the gizzard shad, *Dorosoma*, this single fish being about twice as common in adults as all the minnow family taken together. It made forty per cent. of the food of the wall-eyed pike; a third that of the black bass; nearly half that of the common pike or "pickerel;" two-thirds that of the four specimens of golden shad examined; and a third of the food of the gars. The only other fishes in whose stomachs it was recognized were the yellow cat, *Ictalurus natalis*, and young white bass, Roccus. It thus seems to be the especial food of the large game fishes and other particularly predaceous kinds.

The minnow family (Cyprinidæ) are in our waters especially appropriated to the support of the half-grown game fishes, and the smaller carnivorous kinds. They were found in the wall-eyed pike, the perch, the black bass, the blue-checked sunfish, the croppie, the pirate perch, the pike, the little pickerel, the chub minnow, the yellow cat, the mud-cat, the dogfish, and the gar.

Suckers, Catostomatidæ, I determined only from the pike, the sheepshead, the blue-cheeked sunfish (*cyanellus*), the yellow cat, and the dogfish (*Amia*). Buffalo and carp occurred in the pike, the dogfish, and the above sunfish.

The ponds and muddy streams of the Mississippi valley are the native home of mollusks of remarkable variety and number, and these form a feature of the fauna of the region not less conspicuous and important than its leading groups of fishes. We might, therefore, reasonably expect to find these dominant groups connected by the food relation; and consistently with this

expectation, we observe that the sheepshead, the catfishes, the suckers and the dogfish find an important part of their food in the molluscan forms abundant in the waters which they themselves most frequent. The class as a whole makes about one-fourth of the food of the dogfish and the sheepshead —taking the latter as they come, half-grown and adults together—about half that of the cylindrical suckers—rising to sixty per cent in the red horse—and a considerable ratio (fourteen to sixteen per cent) of the food of the perch, the common catfishes (Amiurus and Ictalurus), the small-mouthed sunfishes, the top minnows, and the shiner (Notemigonus). Notwithstanding the abundance of the fresh-water clams or river mussels (Unio and Anodonta), only a single river fish is especially adapted to their destruction, viz., the white perch or sheepshead, and this species derives, on the whole, a larger part of its food from univalve than from bivalve mollusks, the former eaten especially by half-grown specimens, and the latter being the chief dependence of the adults. The ability of the catfishes to tear the less powerful clams from their shells has been already mentioned. Large clams were eaten freely by the full-grown sheepshead—whose enormous and powerful pharyngeal jaws with their solid pavement teeth are especially adapted to crushing the shells of mollusks—and by the bullheads (Amiurus), especially the marbled cat. The small and thin-shelled Sphæriums are much more frequently objects in the food of the mollusk-eating fishes than are the Unios. This genus alone made twenty-nine per cent of the food of our one hundred and seven specimens of the sucker family, and nineteen per cent of that of a dozen dogfishes. Among the suckers it was eaten greedily by both the cylindrical and the deep-bodied species, although somewhat more freely by the former. Even the river carp, with its weak pharyngeal jaws and delicate teeth, finds these sufficient to crush the shells of Sphærium, and our nineteen specimens had obtained about one-fourth of their food from this genus. Besides the above families, smaller quantities of the bivalve mollusks occurred in the food of one of the sunfishes (*Lepomis pallidus*), and—doubtless by accident only—in the gizzard shad. The gasteropod mollusks (snails of various descriptions) were more abundant than bivalve forms in the sheepshead, sunfish, and all the smaller fishes which feed upon Mollusca, but less abundant in the suckers and the catfishes. In the sheepshead they made one-fifth of the food of the twenty-five specimens examined, but the greater part of these had not yet passed the insectivorous stage, this being much longer continued in the sheepshead than in many other fishes. A few of these univalve Mollusca occurred in the food of the common perch and in certain species of sunfishes —especially the superabundant bream or pumpkin-seed. They made fifteen per cent of the food of the minute top minnows, and occurred in smaller quantities among the darters, the little pickerel, the mud minnows, and the cyprinoids. The heavier river snails, Vivipara and Melantho, were eaten especially by the cylindrical suckers and the catfishes. The delicate pond snails (Succinea, Lemna, and Physa) were taken chiefly by the smaller mollusk-eating fishes— a few of them also by the catfishes and the suckers.

It is from the class of insects that adult fishes derive the most important portion of their food; and, taken as a whole, this class furnishes thirty-eight per cent of the food of all which I examined. The principal insectivorous fishes are the smaller species, whose size and food structures, when adult, unfit them for the capture of Entomostraca and yet do not bring them within reach of fishes or Mollusca. Some of these fishes have peculiar habits

which render them especially dependent upon insect life—the little minnow, Phenacobius, for example, which, according to my studies, makes nearly all its food (ninety-eight per cent.) from insects found under stones in running water. Next are the pirate perch, Aphredoderus (ninety-one per cent.), then the darters (eighty-seven per cent.), the croppies (seventy-three per cent.), half-grown sheepshead (seventy-one per cent.), the shovel fish (fifty-nine per cent.), the chub minnow, Semotilus (fifty-six per cent.), the black warrior sunfish (Chænobryttus) and the brook silversides (each fifty-four per cent.), and the rock bass and the cyprinoid genus Notropis (each fifty-two per cent).

Those which take few insects or none are mostly the mud feeders and the ichthyophagous species, Amia, (the dog-fish) being the only exception to this general statement. Thus we find insects wholly or nearly absent from the adult dietary of the burbot, the pike, the gar, the black bass, the wall-eyed pike, and the great river catfish, and from that of the hickory shad and the mud-eating minnows (the shiner, the fat-head, etc.). It is to be remembered, however, that the larger fishes all go through an insectivorous stage, whether their food when adult be almost wholly other fishes, as with the gar and the pike, or mollusks, as with the sheepshead. The mud-feeders, however, seem not to pass through this stage, but to adopt the limophagous habit as soon as they cease to depend upon Entomostraca.

Terrestrial insects, dropping into the water accidentally or swept in by rains, are evidently diligently sought and largely depended upon by several species, such as the pirate perch, the brook minnow, the top minnows or killifishes (Cyprinodonticlæ), the toothed herring and several cyprinoids (Semotilus, Pimephales, and Notropis).

Among aquatic insects, minute, slender dipterous larvæ are of remarkable importance, making, in fact, nearly one-twelfth of the food of all the fishes studied. They amounted to about one-third the food in fishes as large and important as the red horse and the river carp, and made nearly one-fourth that of fifty-one buffalo fishes. They appear further in considerable quantity in the food of a number of the minnow family (Notropis, Pimephales, etc.), which habitually frequent the swift water of stony streams. Aquatic beetles and larvæ, notwithstanding the abundance of some of the forms, occurred in only insignificant ratios, but were taken by fifty-six specimens. The adult surface beetles, whose zig-zag darting swarms no one can have failed to notice, were not once encountered in my studies.

The almost equally well-known slender water-skippers seem also completely protected by their habits and activity from capture by fishes, only one occurring in the food of all our specimens.

It is from the order Neuroptera that fishes draw a larger part of their food than from any other single insect group. In fact, nearly one-sixth of the entire amount of food consumed by all the fishes examined by me consisted of aquatic larvæ of this order, the greater part of them larvæ of day flies. These Neuroptera larvæ were eaten especially by the miller's thumbs, the sheepshead, the white and striped bass, the common perch, thirteen species of the darters, both the black bass, seven of the sunfishes, the rock bass and the croppies, the pirate perch, the brook silversides, the sticklebacks, the mud minnow, three top minnows, the gizzard shad, the toothed herring, twelve species each of the true minnow family and of the suckers and buffalo, five catfishes, the dogfish and the shovel-fish—seventy species out of the eighty-seven which I studied.

Of the four principal classes of the food of fishes, viz., fishes, mollusks, insects, and *Crustacea*, the latter stand third in importance according to my observations, mollusks alone being inferior to them. That insect larvæ should be more abundant in the food of fresh water fishes than are crustaceans, is a somewhat unexpected fact, but while the former make about twenty-five per cent. of the food of our entire collection, the crustaceans amount to only fourteen per cent. Crayfishes made about a sixth of the food of the burbot, about a tenth that of the common perch, a fourth that of half a dozen gars, and not far from a third that of the black bass, * the dogfish, and our four rock bass. Young crayfishes appeared quite frequently in some of the larger minnows (Semotilus and Hybopsis), and also in catfishes, especially the pond and river bullheads, averaging nearly fifteen per cent. of the entire food of the two most abundant species.

The minute crustaceans commonly grouped as Entomostraca are a much more important element. Among full-grown fishes, I find them especially important in the shovel-fish—where they made two-thirds of the food of the specimens studied—and in the common lake herring. Among the sunfishes at large they were present in only insignificant ratio; but the croppies, distinguished by long and numerous rakers on the anterior gill, had derived about a tenth of their food from these minute crustaceans. In the early spring, especially, when the backwaters of the streams are filled with Entomostraca, the stomachs of these fishes are often distended with the commonest forms. Ten per cent. of the food of the sucker family consisted of them, mostly taken by the deep-bodied species, in which they made a fourth or a fifth of the entire food. This fact is explained, it will be remembered, by the relatively long, slender, and numerous gill-rakers of these fishes. Large river buffalo were occasionally crammed with the smallest of these Entomostraca, only a twenty-fifth of an inch in length.

I have several times remarked the peculiar importance of Entomostraca to the shovel-fish—one of the largest of our fresh-water animals—a fact accounted for by the remarkable branchial strainer of this species, probably the most efficient apparatus of its kind known to the ichthyologist. Here, again, the smallest forms were the most abundant.

Probably to those accustomed to the abundance of true worms in marine situations, no feature of the poverty of fresh-water life will be more striking than the small number of this subkingdom occurring in the course of miscellaneous aquatic collections in the interior. Similarly, we notice that in the food of fishes the occurrence of Vermes is so rarely noticed that they might be left out of account entirely without appreciably affecting any of the important ratios. Catfishes alone seem purposely to eat leeches, these occurring in nine specimens of three different species of this family, and also in one common sucker and in a single shovel-fish. One of the fresh-water *Sponges* (Spongilla) had been eaten in considerable quantities by two examples of the spotted cat taken in September, but this element was not encountered elsewhere in my studies.

That the minutest and simplest of all the animal forms, far too small for the eye of a fish to see without a microscope, should have been recognized in the food of seventeen species of fishes is, of course, to be explained only as an incident of the feeding habit. It is possible, however, that these *Proto-*

* Our specimens—especially of the small-mouthed black bass—were too few in number to make this average reliable.

zoa, where especially abundant, may be recognized in the mass by the delicate sensory structures of the fish; and they seem in most cases to have been taken with mud and slime, rich in organic substances. As most of them are extremely perishable, and can scarcely leave a trace a few seconds after immersion in the gastric juices of the fish, it is probable that they contribute much more generally than our observations indicate to the food of some fishes, especially to those which feed upon the bottom.

Young suckers under six inches in length clearly take them purposely, substituting them in great part for the Entomostraca taken by other fishes of their size and age.

I detected Protozoa in the food of several genera of Cyprinidæ, in the young of buffalo, the river carp, the chub sucker, the red-horse, the stone roller, in the common sucker, in a single gizzard shad, in a stone-cat, and in a top minnow.

The only scavenger fishes of our collection were three species of the common catfishes; the spotted cat, the yellow cat, and the marbled cat—all of which had eaten dead animal matter, including pieces of fish, ham, mice, kittens, and the like. A single large-mouthed black bass had likewise eaten food of this description.

Considering the wealth of vegetation accessible to aquactic animals, and the fact that few other strictly aquatic kinds have the vegetarian habit, it is indeed remarkable that fishes draw from plants an unimportant part of their diet. Taking our nine hundred specimens together, the vegetation eaten by them certainly would have amounted to less than ten per cent of their entire food, and excluding vegetable objects apparently taken by chance, it probably would not reach five per cent.

The greatest vegetarians are among the minnow family. Counting each genus as a unit, I find that the family as a whole obtained from plants about twenty-three per cent of its food. The little Phenicobius, already reported as strictly insectivorous, was the only one studied in which vegetation can scarcely be said to occur.

Certain of the sunfishes evidently take plant food purposely on occasion, this making, for example, nearly a tenth of the food of forty-seven specimens of Lepomis. Among the larger fishes, the principal vegetarians are the gizzard shad, in which this element was reckoned at about a third, taken, however, not separately, but with quantities of mud. A considerable part of the vegetation here included consisted of distillery slops obtained near towns. The buffalo fishes are likewise largely vegetarians, more than a fourth of their food coming from the vegetable kingdom; about a third of this in our specimens being refuse from distilleries. Vegetation made a tenth of the food of the larger genera of catfishes (Amiurus and Ictalurus)—some of it distillery refuse—and nearly as large a ratio of the great Polyodon.

Not infrequently terrestrial vegetable rubbish—seeds of grasses, leaves of plants, and similar matter—was taken in quantity to make it certain that its appropriation was not accidental. The principal mud-eating fishes are the gizzard shad, the common shiner, and certain genera of minnows with elongate intestines and cultrate pharyngeal teeth. Much mud was also taken by the cylindrical members of the sucker family, but apparently as an incident to their search for mollusks.

CONCLUSION.

I cannot attempt to discuss the practical bearing of the mass of data here presented, or of the much greater number which I have withheld, partly because the time is lacking, and partly because I know too little of practical fish-culture; and I will merely call attention to a few illustrative points which have occurred to me in writing.

It would seem that the fact that all young fishes compete, at first, for food must have important practical results tending in various directions. It is probable that all fishes which are not especially adapted to the food requirements of the more valuable fishes are hurtful to them, because they limit the food available for their young. It seems possible that even the food species of the predaceous fishes may multiply to an extent injurious to the latter, since both robber and prey compete while young for the same elements of food. It would seem entirely likely that large fishes, like the shovel-fish, which destroy when adult immense quantities of the proper food of the young, must be reckoned as injurious.

Again, it is evident that the fishes most desirable as food for other kinds are those whose own food is not eaten by valuable species, but exists in practically inexhaustible supplies. The gizzard shad and the mud-feeding minnows are examples of this sort; while the red-horse and other cylindrical suckers answer the purpose almost equally well, since no valuable fishes feed upon mollusks (especially preferred by suckers), and these are among the most abundant animals in our western streams. The fact that they have likewise adapted themselves to civilization, so far at least as to relish distillery slops, is, perhaps, an additional recommendation from this point of view.

The smaller catfishes, being practically omnivorous, are the rivals of every other kind; and being almost perfectly protected from capture by their stout, sharp, poisoned spines, they contribute little to the food supply of other fishes. The common sunfishes are almost equally worthless and injurious from this point of view.

I need scarcely say that the fish-culturist should examine the waters in which young fishes are planted, in order to determine the amount of their appropriate food available. It is not impossible that myriads of whitefish have been set free to perish by starvation before the feeble fry could disperse widely enough to secure a single meal. It seems to me, also, that in every case where it is proposed to introduce a new fish into waters already populated, the first question to be asked should be, what fishes do these waters already contain—and in what numbers—whose food and whose relations to nature generally are substantially the same as those it is intended to introduce?

And, finally, I would call attention to the necessity of keeping continuous watch of the balance and abundance of plant and animal life in its various leading forms in any body of water in which it is thought desirable to maintain especial kinds of fishes in the greatest number possible. The owner of a fish-pond especially, who makes himself acquainted with the entire collection of animals and plants which his pond contains, and keeps the run of these in their variations of number and habit, from season to season and from year to year, will not only get some practical hints thereby, which will aid him in the multiplication and preservation of his fish, but will derive no small amount of pleasure from his observations, and from the reasonings and reflections to which they will give rise.

NOTE ON THE FIRST FOOD OF THE WHITEFISH.

An elaborate account of this research was published in 1883, in the first volume of the Bulletin of the Illinois State Laboratory of Natural History; but as this article was not widely distributed among fish-culturists, the great practical importance of the subject will perhaps justify the following extracts from it: More light was thrown upon the earliest food habits of these fishes by the discovery of raptatorial teeth upon the lower jaw than by the dissections of their alimentary canals. All the families of fishes which I had previously studied whose young were provided with teeth were found strictly dependent at first upon *Entomostraca* and the minuter insect larvæ; while only those whose young were toothless fed to any considerable extent upon other forms. The discovery of teeth in the young whitefish, therefore, placed this species definitely in the group of those carnivorous when young. The fact that the adult was itself toothless interfered in no way with this inference, because other toothless fishes (*Dorosoma*) whose young were furnished with teeth had been found carnivorous at an early age.

The inconclusive character of the results thus far obtained made it necessary to attempt to imitate more closely the natural conditions of the young when hatched in the lake. In February, 1881, I obtained, through the kindness of Mr. Clarke, twenty-five specimens of living young whitefish, saved from a lot which he was planting in the waters of Lake Michigan, off Racine, Wisconsin. I succeeded in conveying them to the laboratory without loss, and there kept them for several days in a glass aquarium and supplied them with an abundance of the living objects to be obtained by drawing a fine muslin net through the stagnant pools of the vicinity. These consisted of many diatoms and filamentous fresh-water Algæ, of two or three species of Cyclops, of *Canthocamptus illinoisensis*, and *Diaptomus sanguineus* among the Copepoda, and of two rather large Cladocera, *Simocephalus vetulus* and *S. americanus*. These little fishes were kept under careful observation for several days, the water in the aquarium being frequently aërated by pouring. Many of them had, however, been injured by handling, and eleven of the specimens died without taking food. It was soon evident that the larger Entomostraca (the *Simocephalus*, and even the *Diaptomus*) were quite beyond the size and strength of these little fishes, and that only the smaller Copepoda, among the animals available, could afford them any food at first. These they followed about from the beginning with signs of peculiar interest, occasionally making irresolute attempts to capture them. Two days after their arrival one of the young whitefish had evidently taken food, which proved, on dissection, to be a small Cyclops. During the next two days nine others began to eat, dividing their attention between the Cyclops above mentioned and the Canthocamptus, and on the 22d two others took a Cyclops each and

a third a Canthocamptus. One of these fishes contained still a large remnant of the egg-sac, showing that the propensity to capture prey must antedate the sensation of hunger. On the 25th the fourteenth and last remaining fish captured its Cyclops, and was itself sacrificed in turn. As an indication of the efficiency of the raptatorial teeth, it may be worth while to note that I saw one of the smallest fishes make a spring at a Cyclops, catch it, give three or four violent wriggles, and drop it dead to the bottom of the tank.

As a general statement of the result of the observations made on these fourteen fishes, we may say that eight of them ate a single Cyclops each, that one took two and another three of the same, that one took a single Canthocamptus, that two specimens captured two each of this genus, and that finally a single fish ate Cyclops and Canthocamptus both. The final conclusion was a highly probable inference that the smallest Entomostraca occurring in the lake would prove to be the natural food of the species.

In order to test this conclusion with precision, I arranged a similar experiment on a larger scale, and under more natural conditions. Through the generosity of the Exposition Company, of Chicago, I was allowed the use of one of the large aquarium tanks in the Exposition building, on the lake shore, and by the repeated kindness of Mr. Clarke, of Northville, Michigan, I was furnished with a much larger number of living whitefish. Five thousand fry were shipped to me in a can of water, but through unfortunate delays in changing cars at intermediate points, about two-thirds of these were dead when they reached my hands. Those living were immediately transferred to the tank, through which the water, taken from the city pipes, had already been allowed to run for several hours. As this water is derived from Lake Michigan at a distance of two miles from the shore, and had to this time the exact temperature of the open lake, the conditions for experiment were as favorable as artificial arrangements could well be made.

Sending a man with a towing net out upon the lake with a boat, or upon the remotest breakwaters, immense numbers of all organic objects in the waters were easily obtained. After enclosing the exit of the tank with a fine wire screen, to prevent the escape of objects placed in it, we poured these collections of all descriptions indiscriminately into the water from day to day, thus keeping the fishes profusely supplied with all the various kinds of food which could possibly be accessible to them in their native haunts. From this tank one hundred fishes were taken daily and placed in alcohol for dissection and microscopic study, to determine precisely the objects preferred by them for food. These were examined at a later date, and all contents of the intestines were mounted entire as microscopic slides, and permanently preserved. A careful study was, of course, made of the organisms of the lake, as shown by the product of the towing-net, and when the experiment was finally ended, it was followed by an equally careful examination of the living contents of the water of the tank at that time.

These fishes, like those previously described, had already reached the age and condition at which it is customary to "plant" them in the lake. The ventrals were still undeveloped, the egg sac had nearly disappeared, the four mandibular teeth were present, and the median fin extended from the tips of the pectorals on the belly to a point opposite the middle of the same fins on the back. In most the egg-sac did not protrude externally, being reduced in some to a droplet of oil, but remaining in a few of a size at least as great as

that of the head. The alimentary canal was, of course, a simple, straight tube, without any distinction of stomach and intestines.

The sufferings of these fry in transit had doubtless weakened the vitality of these survivors, and although every care was taken to keep the water of the tank fresh and pure, about one-third of those remaining died during the progress of the experiment. The aquarium in which they were confined was built of glass, and had a capacity of about one hundred cubic feet. The temperature, tried repeatedly, stood at forty-two Fahrenheit. A steady current of the water of the lake was maintained through this tank, entering through a rose, from which it fell in a spray, thus insuring perfect aëration.

By far the greater part of the organic contents of the water of the lake, as shown by the product of the towing-net, consisted of diatoms in immense variety, which formed always a greenish mucilaginous coating upon the interior of the muslin net. In this were entangled a variety of rotifers, occasional filamentous Algæ, and many Entomostraca, the latter belonging chiefly to the genera Cyclops, Diaptomus and Limnocalanus among the Copepoda, and to Daphnia among the Cladocera.

As the Entomostraca proved to be far the most important elements of this food supply, the particulars respecting them may be properly more fully given. The smallest of all was a Cyclops, then new, but since described by me under the name of *Cyclops thomasi*.* This little Entomostracan is only .04 inch long by .011 wide. The next in size, and by far the most abundant member of this group, was a Diaptomus, likewise new, described in the paper just cited under the name of *Diaptomus sicilis*. This appears in two forms, one, evidently young, in the stage just preceding the adult. Full-grown individuals were .065 inch long by one-fourth that depth. The Limnocalanus was a much larger form, evidently preying, to a considerable extent, upon the two just mentioned. All the Cladocera noticed were *Daphnia hyalina*, an elegant and extremely transparent species, occurring likewise in the lakes of Europe. A single insect larval form (Chironomus) should likewise be mentioned in this connection, since it had about the same size and consistence of the Entomostraca, and was consequently available for food. The specimens of each of the above species from a certain quantity of these collections were counted, in order to give a definite idea of their relative abundance in the lake; the Diaptomus numbered 225, the Cyclops 75, Limnocalanus 7, Daphnia 3, and Chironomus larvæ 1. It was a curious fact, however, that when the water was drawn off at the end of the experiment, more than half the Entomostraca were Limnocalanus; a fact partly to be explained by the predaceous habit of the latter and partly by the facts relating to the food of the fishes themselves, which are presently to be detailed. The fry were placed in the tank and supplied with their first food on the evening of the 12th of March. On the 14th one hundred specimens were removed, and twenty-seven of these were dissected. Twenty were empty, but the remaining seven had already taken food, all Cyclops or Diaptomus. Three had eaten Cyclops only, and six Diaptomus, while two had eaten both. Fourteen of these Entomostraca, seven of each genus, were taken by these seven fishes. From those captured the next day, twenty-five specimens were examined, of which nineteen were without food. Of the remaining six, three had eaten Diaptomus and three Cyclops; five of the former being taken in all, and ten of the

*"On some Entromostraca of Lake Michigan and Adjacent Waters." American Naturalist' Vol. XVI., No. VIII. (August, 1882), pp. 640 and 649.

latter. Three specimens were next examined from those caught on the 19th of March, two of which had devoured Diaptomus, and a third a single *Cyclops thomasi* and a shelled rotifer, *Anuræa striata.* The character of the food at these earliest stages was so well settled by these observations that I deemed it unnecessary to examine the subsequent lots in detail, but passed at once to the specimens taken on the 23d. Twenty-six of these were examined and found to have eaten thirty-three individuals of *Cyclops thomasi,* fourteen of *Diaptomus sicilis,* and fourteen of the minute rotifer already mentioned (*Anuræa striata*). Two had taken a few diatoms (Bacillaria), and one had eaten a filament of an Alga. Cyclops was found in sixteen of the specimens, Diaptomus in nine, and Anuræa in eight, only two of them being empty. The amount of food now taken by individual fishes was much greater than before, one specimen dissected having eaten two Cyclops and six *Diaptomus sicilis,* male and female. Another had taken five Cyclops, one Diaptomus and five examples of *Anuræa striata.* Still another had eaten four of the Cyclops, four Diaptomus and one Anuræa.

Twenty-five specimens were examined from those removed on the 24th of the month, at which time the water of the tank was drawn off and all the remaining fishes bottled. Four of these had not eaten, but the twenty-one others had devoured fifty specimens of *Diaptomus sicilis,* forty-seven of *Cyclops thomasi,* fourteen of *Auuræa striata* and a single *Daphnia hyalina,* the latter being the largest object eaten by any of the fishes. A few examples of their capacity may well be given. The ninth example had eaten six Diaptomus, two *Cyclops thomasi* and one Anuræa; the tenth had taken eight Diaptomus, two Cyclops and an Anuræa; and the twentieth seven Diaptomus and three *Cyclops thomasi.* In two of these examples were small clusters of orange globules, probably representing unicellular Algæ.

Summarizing these data briefly, we find that of the one hundred and six specimens dissected, sixty-three had taken food, and that the ratio of those which were eating increased rapidly the longer the fishes were kept in the aquarium. Only one-fourth of those examined on the fourteenth of the month had taken food, while more than five-sixths of those bottled ten days later had already eaten. The entire number of objects appropriated by these sixty-three fishes was as follows: *Cyclops thomasi,* ninety-seven; *Diaptomus sicilis,* seventy-eight; *Anuræa striata,* twenty-nine; *Daphnia hyalina,* one. Seven of the fishes had eaten unicellular Algæ, two had eaten diatoms, and one filamentous Algæ.

From the above data we are compelled to conclude that the earliest food of the whitefish consists almost wholly of the smallest species of Entomostraca occurring in the lake, since the other elements in their alimentary canals were evidently either taken accidentally, or else appeared in such trivial quantity as to contribute nothing of importance to their support. In fact, two species of Copepoda, *Cyclops thomasi* and *Diaptomus sicilis,* are certainly very much more important to the maintenance of the whitefish in this earliest stage of independent life than all the other organisms in the lake combined. As the fishes increase in size, vigor and activity, they doubtless enlarge their regimen by capturing larger species of Entomostraca, especially Daphnia and Limnocalanus.

A few words respecting the relative abundance of these species at different seasons of the year and their distribution in the lake will have some practical value. We may observe here an excellent illustration of the remarkable uni

formity of the life of the lake as contrasted with that of smaller bodies of water. While in ponds minute animal life is largely destroyed or suspended during the winter, the opening spring being attended by an enormous increase in numbers and rate of multiplication, in Lake Michigan there is but little difference in the products of the collecting apparatus at different seasons of the year.* There is a slight increase in the number of individuals during spring and early summer, but scarcely enough appreciably to affect the food supply of fishes dependent upon them. They are not by any means equally distributed, however, throughout the lake, my own observations tending to show that there are relatively very few of these minute crustaceans to be found at a distance of a few miles from shore, and that, in fact, by far the greater part of them usually occur within a distance of two or three miles out. Indeed, the mouths of the rivers flowing into the lake are ordinarily much more densely populated by these animals than the lake itself, as has been particularly evident at Racine and South Chicago. Neither are they commonly equally distributed throughout the waters in which they are most abundant, but, like most other aquatic animals, occur in shoals. In the deeper portions of the lake many species shift their level, according to the time of day, coming to the surface by night and sinking again when the sun is bright.

These facts make it important to the fish-culturist that the particular situation when it is proposed to plant the fry should be searched at the time when these are to be liberated, to determine whether they will find at once sufficient food for their support. A little experience will easily enable one to estimate the relative abundance of the Entomostraca at any given time and place, and they require nothing for their capture more complicated or difficult of management than a simple net of cheese-cloth or similar material towed behind a boat. This may be weighted and sunk to any desired depth, so that the contents of the water either at the surface or at the bottom, may be ascertained by a few minutes' rowing.—*State Laboratory of Natural History, Champaign, Ill.*

* For definite assurance of this fact I am indebted less to my own observations (which are, however, consistent with it so far as they go), than to the statements of B. W. Thomas, Esq., of Chicago, who, while making a specialty of the Diatomaceæ of the lake, has collected and studied all its organic forms for several yéars, obtaining them from the city water by attaching a strainer to a hydrant many times during every month throughout the year.

7.—SOME OBSERVATIONS UPON THE GRAYLING.

BY J. C. PARKER, OF THE MICHIGAN FISH COMMISSION.

The question as to whether the grayling (*Thymallus tricolor*) could be successfully propagated artificially being practically undecided by this commission, it was decided to prepare waters as nearly in accordance with natural conditions as possible and make as careful and systematic an attempt as we could to solve it. Accordingly ponds were made on the Buck Horn creek, of just sufficient depth to admit of screening and through which the whole creek flowed, with the hope that if placed here they would in the spring—the spawning season—give us an opportunity to observe and handle them under less difficult circumstances than in their native streams. We hoped that as the Buck Horn had originally been a good grayling stream, it would place at our disposal the most advantageous conditions. The ponds being in readiness, the several members of the Michigan Fish Commission proceeded on the 20th of August to the west branch of the Manistee, fifteen miles from the railroad station at Kalkaska, with boats, cans, and camp equipage, prepared to make a week of it. The fish were to be captured with rod and line, it having been demonstrated that this was more certain, and the results more satisfactory, than any attempt to use nets of any description. The result was that at the end of the week we had caught and had in excellent condition about one hundred fine specimens. From five to six of these were put into a can, the temperature of the water—which was comparatively low—kept down by the addition of ice, and nine of these cans loaded into a lumber-wagon and the journey to the station over a bouncing corduroy road commenced. Only one opportunity to change the water en route was afforded, but, notwithstanding all this rough handling, they reached their destination with only the loss of some four or five specimens.

During the winter they were watched and cared for, but the loss was about twenty-five per cent. When the spawning season arrived a close watch was kept to see when any signs of spawn-laying should commence, but we watched in vain. So far as could be ascertained there was nothing to indicate that they had, would, or could ever spawn, and to-day we are no nearer a practical solution of the vexed question than when we commenced. During this, and a subsequent visit to the same locality, I was enabled to make some observations upon their food and their habits in feeding, which may be of interest. Near the camp was a pool in which two small fish had their haunts, one about

six inches in length, and the other half the size. The larger one when at rest was on a bit of clean sand in plain view; the other lay under some sunken drift-wood, dark in color, and under which he concealed himself, only the tip of his nose being visible, and the contrast in color corresponded exactly with their resting places; the larger one was so nearly the color of the sand on which he lay as hardly to be distinguished from it; only when in motion as he arose to the surface for his food; the other was as dark as the sticks under which he lay, showing that the question of color is one of bottom locality and undoubtedly a circumstance of more or less light. I was somewhat surprised at the tenacity with which they adhered to a locality when once domiciled in it. Three or four times I drove them out of their haunts; one afternoon chasing the larger one several rods up the stream, only to find him in the same spot the next day, and when I returned to the same locality, after an absence of four weeks, I found the same fish apparently in the same places. In rising for food I never saw either of them more than a yard from their haunts, and only rarely but a few inches. They would detect their prey at a considerable distance and slowly rise to meet it as it floated to them, and then a sudden flash, and they were back to their respective resting places. The deviation from the point where they lay was, from side to side across the stream, hardly ever but a few inches up or down. One day, when they were rising with more than usual frequency, I carefully crept out on a projecting log until I was nearly over them, and could watch their every movement, and, with watch in hand, counted the "rises" of the larger one for fifteen minutes. In this time he came to the surface and secured his prey fifty times. Sometimes he would rise nearly to the surface and then slowly settle down again, but whenever he actually seized anything he was back to his haunt again with a motion so quick the eye could scarcely follow him. After considerable observation I could detect the particular insect I was sure he would rise for, sometimes before he would show any motion in that direction. Watching his quick, unerring sight, and his ability to detect what was food, and what was not, led me into some generalizations on what their food really was, that were new to me.

In eviscerating fish for any purpose, I have always been in the habit of examining the contents of the stomach, and the stomach of the grayling had always puzzled me by the quantity of vegetable matter so often found in them; but the *a priori* conclusion was that he was necessarily a carnivorous, or insectivorous fish; the thought that he was a vegetarian as well, never occurred to me. I had observed that the fronds of the white cedar—*arbor vitæ*—were quite usually among the contents of the stomach, but I had always considered it as something adventitious, an accident, occurring in the procuring of his food, and not deliberately taken. But a somewhat singular circumstance that occurred upon this last expedition staggered me somewhat. On the afternoon of the day of my arrival, after the tent was pitched, and camp life organized, I proceeded to a pool below a flooding dam near camp, thinking I could secure enough grayling for the supper of myself and little daughter, who accompanied me. I succeeded in securing two nice ones, weighing probably about six or eight ounces each, and upon dressing them and examining the stomachs as usual, judge of my surprise upon finding one of them full of oats; there were eight kernels stored away in first-class style, and my first question was, where in the name of the Prophet could they have come from, for I knew that there wasn't a spear of grain growing within a

dozen miles of this pool and the condition the grain was in showed that they could have been in the stomach but a short time. I finally solved the mystery by remembering that the man who brought us out—we arrived about noon—fed his horse some oats at a point just above the pool, and the grain was either blown into the water or carelessly thrown in by some one. I frequently found in their stomachs portions of the leaves and seeds of the water plants growing in the streams. Among the latter was in several instances a round seed about as large as a No. 4 shot, which I at first thought was a mollusk, a species of spherium, but on examining it with a glass what appeared to the naked eye to be the striations of the shell proved to be the veination of the seed. It may be urged against the vegetarian theory that many fish take that which in no way resembles their ordinary food, as the artificial fly and the different varieties of spoon and spinning baits, and that this particular fish could in no way have had any previous knowledge of oats as food, and consequently the taking of it must be in the nature of a freak rather than a habit, but I do not remember to have ever found in the stomachs of other fish any substance other than their food but which could be accounted for as accidental, while in the grayling the presence of vegetable matter in some forms is of so frequent an occurrence as to point strongly to the fact, that a part of their food at least is vegetable.

Another point in favor of this theory is the peculiar flavor of the fish and that which has given it its specific name. It is a well-known fact that the flesh of all animals is to a greater or less degree flavored by its food. Now, if this fish fed upon exactly the same materials as the brook trout, could there be a reasonable doubt but what its flesh would taste like that of the trout, while the fact is, that it is distinctly different.

You are probably aware of the difference between a liverfed trout and one caught in its native wilds; a difference so patent, that a person relying upon the taste alone would pronounce them an entirely different fish. One thing is certain, whatever its food is, it must have existed in unlimited quantities to have supported such a large multitude of this fish as absolutely swarmed in the northern streams of this State at an early day. D. A. Blodget, now living at Grand Rapids (and one of the pioneers of the Muskegon at the Hersey-branch), told me that when he first built a dam at the mouth of this stream, that in the spring, during the spawning season, when the grayling were trying to find their way to the spawning grounds, that he has seen the inhabitants fill the box of a common lumber wagon full of this fish in a few hours and carry them out into the country, not only one such load, but half a dozen of each spring for several successive years, while as many more must have been taken away in smaller quantities, and he estimated the quantity taken by tons each year; that during the first winter he spent there, he supplied his table with this fish by taking a common nail-rod and sharpening it with his ax, and cutting a barb on it with the same tool, and going to any of the bends in the stream, and cutting a hole in the ice, he could in a little while get all he wanted by thrusting this primitive spear at random into the waters beneath; and as the number of fish that any stream can furnish is to a great extent limited only by the food supply, it seems that so great a number as was then found, not only in this particular stream, but in most all the streams in which they were found, must have had some food in much greater abundance than what is usually found in our ordinary trout streams.—*Grand Rapids, Mich.*

8.—THE DISTRIBUTION OF FRESH-WATER FISHES.

BY PROF. DAVID STARR JORDAN.

When I was a boy and went fishing in the brooks of western New York, I noticed that the different streams did not always have the same kinds of fishes in them. Two streams in particular in Wyoming county, not far from my father's farm, engaged in this respect my special attention. Their sources are not far apart, and they flow in opposite directions, on opposite sides of a low ridge—an old glacial moraine, something more than a mile across. The Oatka creek flows northward from this ridge, while the East Coy runs toward the southeast on the other side of it, both flowing ultimately into the same river, the Genesee.

It does not require a very careful observer to see that in these two streams the fishes are not quite the same. The streams themselves are similar enough. In each the waters are clear and fed by springs. Each flows over gravel and clay, through alluvial meadows, in many windings, and with elms and alders "in all its elbows." In both streams we were sure of finding trout (*Salvelinus fontinalis* Mitchill), and in one of them the trout are still abundant. In both we used to catch the brook chub (*Semotilus atromaculatus* Mitchill), or as we called it, the "horned dace;" and in both were large schools of shiners (*Notropis megalops* Rafinesque) and of suckers (*Catostomus teres* Mitchill). But in every deep hole, and especially in the mill-ponds along the East Coy creek, the horned pout (*Ameiurus melas* Rafinesque) swarmed on the mucky bottoms. In every eddy, or in the deep hole worn out at the root of the elm trees, could be seen the sunfish (*Lepomis gibbosus* Linnæus), strutting in green and scarlet, with spread fins keeping intruders away from its nest. But in the Oatka creek were found neither horned pout nor sunfish, nor have I ever heard that either has been taken there. Then besides these nobler fishes, worthy of a place on every school-boy's string, we knew by sight, if not by name, numerous smaller fishes, darters (*Etheostoma flabellare* Rafinesque) and minnows (*Rhinichthys atronasus* Mitchill), which crept about in the gravel on the bottom of the East Coy, but which we never recognized in the Oatka.

There must be a reason for differences like these, in the streams themselves or in the nature of the fishes. The sunfish and the horned pout are home-loving fishes to a greater extent than the others which I have mentioned; still, where no obstacles prevent, they are sure to move about. There must be, then, in the Oatka some sort of a barrier, or strainer, which keeping

these species back permits others more adventurous to pass; and a wider knowledge of the geography of the region showed that such is the case. Farther down in its course, the Oatka falls over a ledge of rock, forming a considerable waterfall at Rock Glen. Still lower down its waters disappear in the ground, sinking into some limestone cavern or gravel-bed, from which they reäppear, after some six miles, in the large springs at Caledonia. Either of these barriers might well discourage a quiet-loving fish; while the trout and its active associates have sometime passed them, else we should not find them in the upper waters in which they alone form the fish-fauna. This problem is a simple one; a boy could work it out, and the obvious solution seems to be satisfactory.

Since those days I have been a fisherman in many waters—not an angler exactly, but one who fishes for fish, and to whose net nothing large or small ever comes amiss; and wherever I go I find cases like this.

We do not know all the fishes of America yet, nor all those well that we know by sight; still this knowledge will come with time and patience, and to procure it is a comparatively easy task. It is also easy to ascertain the more common inhabitants of any given stream. It is difficult, however, to obtain negative results which are really results. You cannot often say that a species does not live in a certain stream. You can only affirm that you have not yet found it there, and you can rarely fish in any stream so long that you can find nothing that you have not taken before. Still more difficult is it to gather the results of scattered observations into general statements regarding the distribution of fishes. The facts may be so few as to be misleading, or so numerous as to be confusing; and the few writers who have taken up this subject in detail have found both these difficulties to be serious. Whatever general proposition we may maintain must be stated with the modifying clause of "other things being equal;" and other things are never quite equal.

Still less satisfactory is our attempt to investigate the causes on which our partial generalizations depend—to attempt to break to pieces the "other things being equal" which baffle us in our search for general laws.

We now recognize about six hundred species of fishes as found in the fresh waters of North America, north of the Tropic of Cancer, these representing thirty-four of the natural families. As to their habits, we can divide these species rather roughly into the four categories proposed by Professor Cope, or, as we may call them—

(1) Lowland fishes; as the bow-fin, pirate perch, large-mouthed black bass, sunfishes and some catfishes.

(2) Channel fishes; as the channel catfish, the moon-eye, gar pike, buffalo fishes and drum.

(3) Upland fishes; as many of the darters, shiners and suckers, and the small-mouthed black bass.

(4) Mountain fishes; as the brook trout, and many of the darters and minnows.

To these we may add the more or less distinct classes of (5) Lake fishes, inhabiting only waters which are deep, clear and cold, as the various species of whitefish and the great lake trout; (6) Anadromous fishes, or those which run up from the sea to spawn in fresh waters, as the salmon, sturgeon, shad and striped bass; (7) Catadromous fishes, like the eel, which pass down to

spawn in the sea; (8) Brackish-water fishes, which thrive best in the debatable waters of the river-mouths, as most of the sticklebacks and the killifishes.

As regards the range of the species, we have every possible gradation from those which seem to be confined to a single river, and are rare even in their restricted habitat, to those which are in a measure cosmopolitan,* ranging everywhere in suitable waters.

Still, again, we have all degrees of constancy and inconstancy in what we regard as the characters of a species. Those found only in a single river basin are usually uniform enough; but the species having a wide range usually vary much in different localities. Continued explorations bring to light from year to year, new species; but the number of new forms now discovered each year is usually less than the number of recognized species which are yearly proved to be untenable. Three complete lists of the fresh-water fishes of the United States have been published by the present writer. That of Jordan and Copeland, † published in 1876, enumerates 670 species. That of Jordan ‡ in 1878 contains 665 species, and that of Jordan § in 1885, 587 species, although upwards of 75 new species were detected in the nine years which elapsed between the first and the last list. Additional specimens from intervening localities are often found to form connecting links among the nominal species, and thus several supposed species become in time merged in one. Thus the common channel catfish (*Ictalurus punctatus* Rafinesque) of our rivers has been described as a new species not less than twenty-five times, on account of differences, real or imaginary, but comparatively trifling in value.

Where species can readily migrate, their uniformity is preserved; but whenever a form becomes localized its representatives assume some characters not shared by the species as a whole.

Comparing a dozen fresh specimens of almost any kind of fish from any body of water with an equal number from somewhere else, one will rarely fail to find some sort of differences—in size, in form, in color. These differences are obviously the reflex of differences in the environment, and the collector of fishes seldom fails to recognize them as such; often it is not difficult to refer the effect to the conditions. Thus, fishes from grassy bottoms are darker than those taken from over sand, and those from a bottom of muck are darker still, the shade of color being, in some way not well understood, dependent on the color of the surroundings. Fishes in large bodies of water reach a larger size than the same species in smaller streams or ponds. Fishes from foul or sediment laden waters are paler in color and slenderer in form than those from waters which are clear and pure. Again, it is often true that specimens from northern waters are often less slender in body than those from farther south; and so on. Other things being equal, the more remote the localities from each other, the greater are these differences.

It is evident, from these and other facts, that the idea of a separate creation for each species of fishes in each river basin, as entertained by Agassiz, is wholly incompatible with our present knowledge of the specific distinctions or of the geographical distribution of fishes. This is an unbroken gradation

* Thus the chub-sucker (*Erimyzon sucetta*) in some of its varieties ranges everywhere from Maine to Dakota, Florida and Texas; while a number of other species are scarcely less widely distributed.

† Check List of the Fishes of the Fresh Waters of North America, by David S. Jordan and Herbert E. Copeland. Bulletin of the Buffalo Society of Natural History, 1876, pp. 133-164.

‡ A Catalogue of the Fishes of the Fresh Waters of North America. Bulletin of the United States Geological Survey, 1878, pp. 407-442.

§ A Catalogue of the Fishes known to inhabit the Waters of North America North of the Tropic o Cancer. Annual Report of the Commissioners of Fish and Fisheries for 1884 and 1885.

in the variations from the least to the greatest—from the peculiarities of the individual, through local varieties, geographical sub-species, species, sub-genera, genera, families, super-families, and so on, until all fish-like vertebrates are included in a single bond of union.

It is, however, evident that not all American types of fishes had their origin in America, or even first assumed in America their present forms. Some of these are perhaps immigrants from Northern Asia, where they still have their nearest relatives. Still others are evidently modified importations from the sea; and of these some are very recent immigrants, land-locked species which have changed very little from the parent stock.

We can say, in general, that in all waters not absolutely uninhabitable there are fishes. The processes of natural selection have given to each kind of river or lake species of fishes adapted to the conditions of life which obtain there. There is no condition of water, of bottom, of depth, of speed of current, but finds some species with characters adjusted to it. These adjustments are, for the most part, of long standing; and the fauna of any single stream has, as a rule, been produced by immigration from other regions or from other streams. Each species has an ascertainable range of distribution, and within this range we may be reasonably certain to find it in any suitable waters.

But every species has beyond question some sort of limit to its distribution, some sort of barrier which it has never passed in all the years of its existence. That this is true becomes evident when we compare the fish-faunæ of widely separated rivers. Thus the Sacramento, Connecticut, Rio Grande and St. John's rivers have not a single species in common; and with one or two exceptions, not a species is common to any two of them. None of these has any species peculiar to itself, and each shares a large part of its fish-fauna with the water-basin next to it. It is probably true that the faunæ of no two distinct hydrographic basins are wholly identical, while, on the other hand, there are very few species confined to a single one. The supposed cases of this character, some twenty in number, occur chiefly in the streams of the South Atlantic States and of Arizona. All of these need, however, the confirmation of further exploration. It is certain that in no case has an entire river fauna originated independently from the divergence into separate species of the descendants of a single type.

The existence of boundaries to the range of species implies, therefore, the existence of barriers to their diffusion. We may now consider these barriers, and in the same connection, the degree to which they may be overcome.

Least important of these are the barriers which may exist within the limits of any single basin, and which tend to prevent a free diffusion through its waters of species inhabiting any portion of it. In streams flowing southward, or across different parallels of latitude, the difference in climate becomes a matter of importance. The distribution of species is governed very largely by the temperature of the water. Each species has its range in this respect—the free-swimming fishes, notably the trout, being most affected by it; the mud loving or bottom fishes, like the catfishes, least. The latter can reach the cool bottoms in hot weather, or the warm bottoms in cold weather, thus keeping their own temperature more even than that of the surface of the water. Although water communication is perfectly free for most of the length of the Mississippi, there is a material difference between the faunæ of the stream in Minnesota and in Louisiana. This difference is

caused chiefly by the difference in temperature occupying the difference in latitude. That a similar difference of longitude, with free water communication, has no appreciable importance, is shown by the almost absolute identity of the fish-faunæ of Lake Winnebago and Lake Champlain. While many large fishes range freely up and down the Mississippi, a majority of the species do not do so, and the fauna of the upper Mississippi has more in common with that of the tributaries of Lake Michigan than it has with that of the Red River or the Arkansas. The influence of the climate is again shown in the paucity of the fauna of the cold waters of Lake Superior, as compared with that of Lake Michigan. The majority of our species cannot endure the cold. In general therefore, cold or Northern waters contain fewer species than Southern waters do, though the number of individuals of any one kind may be greater. This is shown in all waters, fresh or salt. The fisheries of the Northern seas are more extensive than those of the Tropics. There are more fishes there, but they are less varied in kind. The writer once caught seventy-five species of fishes in a single haul of the seine at Key West, while on Cape Cod he obtained with the same net but forty-five species in the course of a week's work. Thus it comes that the angler, contented with many fishes of few kinds, goes to Northern streams to fish, while the naturalist goes to the South.

But in some streams the difference in latitude is significant, and the chief differences in temperature come from differences in elevation, or from the distance of the waters from the colder source. Often the lowland waters are so different in character as to produce a marked change in the quality of their fauna. These lowland waters may form a barrier to the free movements of upland fishes; but that this barrier is not impassable is shown by the identity of the fishes in the streams (for example, Elk river, Duck river, etc.) of the uplands of middle Tennessee with those of the Holston and French Broad. Again, streams of the Ozark mountains, similar in character to the rivers of East Tennessee, have an essentially similar fish-fauna, although between the Ozarks and the Cumberland range lies an area of lowland bayous, into which such fishes are never known to penetrate. We can, however, imagine that these upland fishes may be sometimes swept down from one side or the other into the Mississippi, from which they might ascend on the other side. But such transfers certainly do not often happen. This is apparent from the fact that the two faunæ* are not quite identical, and in some cases the same species are represented by perceptibly different varieties on one side and the other. The time of the commingling of these faunæ is perhaps now past, and it may have occurred only when the climate of the intervening regions was colder than at present.

The effect of waterfalls and cascades as a barrier to the diffusion of most species is self-evident; but the importance of such obstacles is less, in the course of time, than might be expected. In one way or another very many species have passed these barriers. The falls of the Cumberland limit the range of most of the larger fishes of the river, but the streams above it have their quota of darters and minnows. It is evident that the past history of the stream must enter as a factor into this discussion, but this past history it

*There are three species of darters (*Etheostoma copelandi* Jordan; *Etheostoma evides* Jordan and Copeland; *Etheostoma scierum* Swain) which are now known only from the Ozark region or beyond and from the uplands of Indiana, not yet having been found at any point between Indiana and Missouri. These constitute perhaps isolated colonies, now separated from the parent stock in Arkansas by the prairie districts of Illinois, a region at present uninhabitable for these fishes. But the non-occurrence of these species over the intervening areas needs confirmation, as do most similar cases of anomalous distribution.

is not always possible to trace. Dams or artificial waterfalls now check the free movement of many species, especially those of migratory habits; while, conversely, numerous other species have extended their range through the agency of canals (thus, *Dorosoma cepedianum* Le Sueur, and *Clupea chrysochloris* Rafinesque, have found their way into Lake Michigan through canals).

Every year fishes are swept down the rivers by the winter's floods; and in the spring, as the spawning season approaches, almost every species is found working its way up the stream. In some cases, notably the Quinnat salmon (*Oncorhynchus tschawytscha* Walbaum) and the blueback salmon (*Oncorhynchus nerka* Walbaum), the length of these migrations is surprisingly great. To some species rapids and shallows have proved a sufficient barrier, and other kinds have been kept back by unfavorable conditions of various sorts. Streams whose waters are always charged with silt or sediment, as the Missouri, Arkansas, or Brazos, do not invite fishes; and even the occasional floods of red mud such as disfigure otherwise clear streams, like the Red river or the Colorado (of Texas), are unfavorable. Extremely unfavorable also is the condition which obtains in many rivers of the Southwest; as for example, the Red river, the Sabine, and the Trinity, which are full from bank to bank in winter and spring, and which dwindle to mere rivulets in the autumn droughts.

In general, those streams which have conditions most favorable to fish-life will be found to contain the greatest number of species. Such streams invite immigration; and in them the struggle for existence is individual against individual, species against species, and not a mere struggle with hard conditions of life. Some of the conditions most favorable to the existence in any stream of a large number of species of fishes are the following, the most important of which is the one mentioned first: Connection with a large hydrographic basin; a warm climate; clear water; a moderate current; a bottom of gravel (preferably covered by a growth of weeds); little fluctuation during the year in the volume of the stream or in the character of the water.

Limestone streams usually yield more species than streams flowing over sandstone, and either more than the streams of regions having metamorphic rocks. Sandy bottoms usually are not favorable to fishes. In general, glacial drift makes a suitable river bottom, but the higher temperature usual in regions beyond the limits of the drift gives to certain southern streams conditions still more favorable. These conditions are all well realized in the Washita river in Arkansas, and in various tributaries of the Tennessee, Cumberland and Ohio; and in these, among American streams, the greatest number of species has been recorded.

The isolation and the low temperature of the rivers of New England have given to them a very scanty fish-fauna as compared with the rivers of the south and west. This fact has been noticed by Professor Agassiz, who has called New England a "zoölogical island." *

In spite of the fact that barriers of every sort are sometimes crossed by fresh-water fishes, we must still regard the matter of freedom of water communication as the essential one in determining the range of most species. The larger the river basin, the greater the variety of conditions likely to

*"In this isolated region of North America, in this zoological island of New England, as we may call it, we find neither Lepidosteus, nor Amia, nor Polyodon, nor Amblodon (*Aplodinotus*), nor Grystes (*Micropterus*), nor Centrarchus, nor Pomoxis, nor Amploplites nor Calliurus, (*Chænobrytus*), nor Carpiodes, nor Hyodon, nor indeed any of the characteristic forms of North American fishes so common everywhere else, with the exception of two Pomotis (*L pomis*), one Boleosoma, and a few Catostomus."—Agassiz, *Amer. Journ. Sci. Arts*, 1854.

be offered in it, and the greater the number of its species. In case of the divergence of new forms by the processes called "natural selection," the greater the number of such forms which may have spread through its waters; the more extended any river basin, the greater are the chances that any given species may sometime find its way into it; hence the greater the number of species that actually occur in it, and, freedom of movement being assumed, the greater the number of species to be found in any one of its affluents.

Of the six hundred species of fishes found in the rivers of the United States, about two hundred have been recorded from the basin of the Mississippi. From fifty to one hundred of these species can be found in any one of the tributary streams of the size, say, of the Housatonic river or the Charles. In the Connecticut river there are about eighteen species permanently resident; and the number found in the streams of Texas is not much larger, the best-known of these, the Rio Colorado, having yielded but twenty-four species.

The waters of the great basin have not yet been fully explored. The number of species now known from this region is about seventy-five. This number includes the fauna of the upper Rio Grande, the Snake river, and the Colorado, as well as the fishes of the tributaries of the great Salt Lake. This list is composed almost entirely of a few genera of suckers (*Catostomus, Pantosteus, Chasmistes*), minnows, (*Squalius, Gila, Ptychocheilus,* etc), and trout (*Salmo mykiss* and its varieties). None of the catfishes, perch, darters, or sunfishes, mooneyes, killifishes, and none of the ordinary eastern types of minnows (genera *Notropis, Chrosomus,* etc.) have passed the barrier of the Rocky Mountains.

West of the Sierra Nevada, the fauna is still more scanty, but fifty species being enumerated. This fauna, except for certain immigrants (as the fresh water surf-fish [*Hysterocarpus traski*] and the species of salmon) from the sea, is of the same general character as that of the great basin, though most of the species are different. This latter fact would indicate a considerable change, or "evolution," since the contents of the two faunæ were last mingled. There is a considerable difference between the fauna of the Columbia and that of the Sacramento. The species which these two basins have in common are chiefly those which at times pass out into the sea. The rivers of Alaska contain but few species, barely a dozen in all, most of these being found also in Siberia and Kamtschatka. In the scantiness of its faunal list, the Yukon agrees with the Mackenzie river, and with Arctic rivers generally.

There can be no doubt that the general tendency is for each species to extend its range more widely until all localities suitable for its growth are included. The various agencies of dispersal which have existed in the past are still in operation. There is apparently no limit to their action. It is probable that new "colonies" of one species or another may be planted each year in waters not heretofore inhabited by such species. But such colonies become permanent only where the conditions are so favorable that the species can hold its own in the struggle for food and subsistence. That various modifications in the habitat of certain species have been caused by human agencies is of course too well known to need discussion here.

We may next consider the question of water-sheds or barriers which separate one river basin from another.

Of such barriers in the United States, the most important and most effective is unquestionably that of the main chain of the Rocky Mountains. This

is due in part to its great height, still more to its great breadth, and most of all, perhaps, to the fact that it is nowhere broken by the passage of a river. But two species—the red-throated or Rocky Mountain trout (*Salmo mykiss* Walbaum [=*purpuratus* Pallas]) and the Rocky Mountain whitefish (*Coregonus williamsoni* Girard)—are found on both sides of it, at least within the limits of the United States; while many genera, and even several families, find in it either an eastern or a western limit to their range. In a few instances representative species, probably modifications or separated branches of the same stock, occur on opposite sides of the range, but there are not many cases of correspondence even thus close.

It is easy to account for the separation of the faunæ; but how shall we explain the almost universal diffusion of the whitefish and the trout in suitable waters on both sides of the dividing ridge? We may notice that these two are the species which ascend highest in the mountains, the whitefish inhabiting the mountain pools and lakes, the trout ascending all brooks and rapids in search of their fountain-heads. In many cases the ultimate dividing ridge is not very broad, and we may imagine that at some time spawn or even young fishes may have been carried across by birds or other animals or by man—or more likely by the dash of some summer whirlwind. Once carried across in favorable circumstances, the species might survive and spread.

I have seen an example of how such transfer of species may be accomplished, which shows that we need not be left to draw on the imagination to invent possible means of transit.

There are few water-sheds in the world better defined than the mountain range which forms the "backbone" of Norway. I lately climbed a peak in this range, the Suletind. From its summit I could look down into the valleys of the Lära and the Bägna, flowing in opposite directions to opposite sides of the peninsula. To the north of the Suletind is a large double lake called the Sletningenvand. The maps show this lake to be one of the chief sources of the westward-flowing river Lära. This lake is in August swollen by the melting of the snows, and at the time of my visit it was visibly the source of both these rivers. From its southeastern side flowed a large brook into the valley of the Bägna, and from its southwestern corner, equally distinctly, came the waters which fed the Lära. This lake, like similar mountain ponds in all northern countries, abounds in trout; and these trout certainly have for part of the year an uninterrupted line of water communication from the Sognefjord on the west of Norway to the Christianiafjord on the southeast—from the North Sea to the Baltic. Part of the year the lake has probably but a single outlet through the Lära. A higher temperature would entirely cut off the flow into the Bägna, and a still higher one might dry up the lake altogether. This Sletningenvand,* with its two outlets on the summit of a sharp water-shed, may serve to show us how other lakes, permanent or temporary, may elsewhere have acted as agencies for the transfer of fishes. We can also see how it might be that certain mountain fishes

* Since the above was written I have been informed by Professor John M. Coulter, who was one of the first explorers of the Yellowstone Park, that such a condition still exists on the Rocky Mountain Divide. In the Yellowstone Park is a marshy tract, traversable by fishes in the rainy season, and known as the "Two-Ocean Water." In this tract rise tributaries both of the Snake river and of the Yellowstone. Similar conditions apparently exist on other parts of the Divide, both in Montana and in Wyoming.

Professor John C. Branner calls my attention to a marshy upland which separates the valley of the La Plata from that of the Amazon, and which permits the free movement of fishes from the Paraguay river to the Tapajos. It is well known that through the Cassiquiare river the Rio Negro, another branch of the Amazon, is joined to the Orinoco river. It is thus evident that almost all the waters of eastern South America form a single basin, so far as the fishes are concerned.

should be so transferred while the fishes of the upland waters may be left behind. In some such way as this we may imagine the trout and the whitefish to have attained their present wide range in the Rocky Mountain region; and in similar manner perhaps the Eastern brook trout (*Salvelinus fontinalis* Mitchill) and some other mountain species (*Notropis rubricroceus* Cope; *Rhinichthys atronasus* Mitchill, etc.) may have been carried across the Alleghanies.

The Sierra Nevada constitutes also a very important barrier to the diffusion of species. This is, however, broken by the passage of the Columbia river, and many species thus find their way across it. That the waters to the west of it are not unfavorable for the growth of eastern fishes is shown by the fact of the rapid spread of the common eastern catfish (*Ameiurus nebulosus* Le Sueur) or horned pout, when transported from the Schuylkill to the Sacramento. This fish is now one of the important food fishes of the San Francisco markets. It has become in fact, an especial favorite with the Chinaman—himself also an immigrant, and presenting certain analogies with the fish in question, as well in temperament as in habits.

The mountain mass of Mount Shasta is as already stated, a considerable barrier to the range of fishes, though a number of species find their way around it through the sea. The lower and irregular ridges of the Coast Range are of small importance in this regard, as the streams of their east slope reach the sea on the west through San Francisco Bay. Yet the San Joaquin contains a few species, not yet recorded, from the smaller rivers of southwestern California.

The main chain of the Alleghanies forms a barrier of importance separating the rich fish-fauna of the Tennessee and Ohio basins from the scantier faunæ of the Atlantic streams. Yet this barrier is crossed by many more species than is the case with either the Rocky Mountains or the Sierra Nevada. It is lower, narrower, and much more broken—as in New York, in Pennsylvania, and in Georgia there are several streams which pass through it or around it. The much greater age of the Alleghany chain, as compared with the Rocky Mountains, seems not to be an element of any importance in this connection. Of the fish which cross this chain, the most prominent is the brook trout (*Salvelinus fontinalis*), which is found in all suitable waters from Hudson's Bay to the head of the Chattahoochee. A few other species are locally found in the headwaters of certain streams on opposite sides of the range. An example of this is the little red "fall fish" (*Notrobis rubicroceus* Cope), found only in the mountain tributaries of the Savannah and the Tennessee. We may suppose the same agencies to have assisted these species that we have imagined in the case of the Rocky Mountain trout, and such agencies were doubtless more operative in the times immediately following the glacial epoch than they are now.

The passage of species from stream to stream along the Atlantic slope deserves a moment's notice. It is, under present conditions, impossible for any mountain or upland fish, as the trout or the miller's thumb (*Cottus richardsoni* Agassiz), to cross from the Potomac river to the James, or from the Neuse to the Santee, by descending to the lower courses of the rivers, and thence passing along either through the swamps or by way of the sea. The lower courses of these streams, warm and muddy, are uninhabitable by such fishes. Such transfers are, however, possible farther north. From the rivers of Canada and from many rivers of New England the trout does descend to

the sea and into the sea, and farther north the whitefish does this also. Thus these fishes readily pass from one river basin to another. As this is the case now everywhere in the North, it may have been the case farther south in the time of the glacial cold. We may, I think, imagine a condition of things in which the snow fields of the Alleghany chain might have played some part in aiding the diffusion of cold-loving fishes. A permanent snow-field on the Blue Ridge in western North Carolina might render almost any stream in the Carolinas suitable for trout, from its source to its mouth. An increased volume of colder water might carry the trout of the head-streams of the Catawba and the Savannah as far down as the sea. We can even imagine that the trout reached these streams in the first place through such agencies, though of this there is no positive evidence. For the presence of trout in the upper Chattahoochee, we must account in some other way.

It is noteworthy that the upland fishes are nearly the same in all these streams, until we reach the southern limit of possible glacial influence. South of western North Carolina, the faunæ of the different river basins appear to be more distinct from one another. Certain ripple-loving types* are represented by closely related but unquestionably different species in each river basin, and it would appear that a thorough mingling of the upland species in these rivers has never taken place.

With the lowland species of the southern rivers it is different. Few of these are confined within narrow limits. The streams of the whole South Atlantic and Gulf Coast flow into shallow bays, mostly bounded by sand-pits or sand-bars which the rivers themselves have brought down. In these bays the waters are often neither fresh nor salt; or rather, they are alternately fresh and salt, the former condition being that of the winter and spring. Many species descend into these bays, thus finding every facility for transfer from river to river. There is a continuous inland passage in fresh or brackish waters, traversable by such fishes, from Chesapeake Bay nearly to Cape Fear; and similar conditions exist on the coasts of Louisiana, Texas and much of Florida. In Perdido Bay I have found fresh-water minnows (*Notropis cercostigma; Notropis xænocephalus*), and silversides (*Labidesthes sicculus*), living together with marine gobies (*Gobiosoma molestum*) and salt-water eels (*Myrophis punctatus*). Fresh-water alligator gars (*Lepisosteus tristœchus*) and marine sharks compete for the garbage thrown over from the Pensacola wharves. In Lake Pontchartrain the fauna is a remarkable mixture of fresh-water fishes from the Mississippi and marine fishes from the Gulf. Channel-cats, sharks, sea-crabs, sunfishes and mullets can all be found there together. It is therefore to be expected that the lowland fauna of all the rivers of the Gulf States would closely resemble that of the lower Mississippi; and this, in fact, is the case.

The low and irregular water-shed which separates the tributaries of Lake Michigan and Lake Erie from those of the Ohio is of little importance in

*The best examples of this are the following: In the Santee basin are found *Notropis pyrrhomelas*, *Notropis niveus*, and *Notropis chloristius;* in the Altamaha, *Notropis xœnurus* and *Notropis callisemus;* in the Chattahoochee, *Notropis hypselopterus* and *Notropis eurystomus;* in the Alabama, *Notropis cœruleus, Notropis trichroistius*, and *Notropis callistius*. In the Alabama, Escambia, Pearl and numerous other rivers, is found *Notropis cercostigma*. This species descends to the sea in the cool streams of the pine-woods. Its range is wider than that of the others, and in the rivers of Texas it reappears in the form of a scarcely distinct variety, *Notropis venustus*. In the Tennessee and Cumberland, and in the rivers of the Ozark range, is *Notropis galacturus;* and in the upper Arkansas *Notropis camurus*—all distinct species of the same general type. Northward, in all the streams from the Potomac to the Oswego, and westward to the Des Moines and the Arkansas occurs a single species or this type, *Notropis whipplei*. But this species is not known from any of the streams inhabited by any of the other species mentioned, although very likely it is the parent stock of them all.

determining the range of species. Many of the distinctively northern fishes are found in the head-waters of the Wabash and Scioto. The considerable difference in the general fauna of the Ohio Valley as compared with that of the streams of Michigan is due to the higher temperature of the former region, rather than to any existing barriers between the river and the Great Lakes. In northern Indiana the water-shed is often swampy, and in many places large ponds exist in the early spring.

At times of heavy rains many species will move through considerable distances by means of temporary ponds and brooks. Fishes that have thus emigrated often reach places ordinarily inaccessible, and people finding them in such localities often imagine that they have "rained down." Once, near Indianapolis, after a heavy shower, I found in a furrow in a corn-field a small pike (*Esox vermiculatus* Le Sueur), some half a mile from the creek in which he should belong. The fish was swimming along in a temporary brook, apparently wholly unconscious that he was not in his native stream. Migratory fishes, which ascend small streams to spawn, are especially likely to be transferred in this way. By some such means any of the water-sheds in Ohio, Indiana, or Illinois may be passed.

It is certain that the limits of Lake Erie and Lake Michigan were once more extended than now. It is reasonably probable that some of the territory now drained by the Wabash and the Illinois was once covered by the waters of Lake Michigan. The cisco (*Coregonus artedi sisco*, Jordan), of Lake Tippecanoe, Lake Geneva, and the lakes of the Oconomowoc chain, is evidently a modified descendant of the so-called lake herring (*Coregonus artedi* Le Sueur). Its origin most likely dates from the time when these small deep lakes of Indiana and Wisconsin were connected with Lake Michigan. The changes in habits which the cisco has undergone are considerable. The changes in external habits are but trifling. The presence of the cisco in these lakes and its periodical disappearance—that is retreat into deep water when not in the breeding season—has given rise to such nonsensical discussion as to whether any or all of these lakes are still joined to Lake Michigan by subterranean channels. Several of the larger fishes, properly characteristic of the Great Lake region (as, *Lota lota maculosa; Percopsis guttatus; Esox masquinongy*), are occasionally taken in the Ohio river, where they are usually recognized as rare stragglers. The difference in physical conditions is prob ably the sole cause of their scarcity in the Ohio basin.

The similarity of the fishes in the different streams and lakes of the Great Basin is doubtless to be attributed to the general mingling of their waters which took place during and after the glacial epoch. Since that period the climate in that region has grown hotter and drier, until the overflow of the various lakes into the Columbia basin through the Snake river has long since ceased. These lakes have become isolated from each other, and many of them have become salt or alkaline and therefore uninhabitable. In some of these lakes certain species may now have become extinct which still remain in others. In some cases, perhaps, the differences in surrounding may have caused divergence into distinct species of what was once one parent stock. The suckers in Lake Tahoe (*Catostomus tahoensis*, in Lake Tahoe; *Catostomus macrocheilus* and *discobolus*, in the Columbia; *Catostomus fecundas, Catostomus ardens*; *Chasmistes liorus* and *Pantosteus generosus* in Utah Lake) and those in Utah Lake are certainly now different from each other and from those in the Columbia. The trout (*Salma mykiss*, et vars. *henshawi* and *vir-*

ginalis) in the same waters can be regarded as more or less tangible varieties only, while the whitefishes (*Coregonus Williamsoni*) show no differences at all. The differences in the present faunæ of Lake Tahoe and Utah Lake must be chiefly due to influences which have acted since the glacial epoch, when the whole Utah basin was part of the drainage of the Columbia.

To certain species of upland or mountain fishes, the depression of the Mississippi basin itself forms a barrier which cannot be passed. The black-spotted trout (*Salmo fario* L., in Europe; *Salmo labrax* Pallas, etc., in Asia; *Salmo gairdneri* Richardson, in streams of the Pacific Coast. *Salmo mykiss* Walbaum, in Kamtschatska, Alaska, and throughout the Rocky Mountain range to the Mexican boundary, and the headwaters of the Kansas, Platte, and Missouri), very closely related species of which abound in all waters of Northern Asia, Europe, and western North America, has nowhere crossed the basin of the Mississippi, although one of its species finds no difficulty in passing Behring Strait. The trout and whitefish of the Rocky Mountain region are all species different from those of the Great Lakes or the streams of the Alleghany system. To the grayling, the trout, the whitefish, the pike, and to arctic and sub-arctic species generally, Behring Strait has evidently proved no serious obstacle to diffusion; and it is not unlikely that much of the close resemblance of the fresh-water faunæ of northern Europe, Asia and North America is due to this fact. To attempt to decide from which side the first migration came in regard to each group of fishes might be interesting; but without a wider range of facts than is now in our possession, such attempts would be mere guesswork and without value. The interlocking of the fish-faunæ of Asia and North America presents, however, a number of interesting problems, for numerous migrations in both directions have doubtless taken place.

I could go on indefinitely with the discussion of special cases, each more or less interesting or suggestive in itself, but the general conclusion is in all cases the same.

The present distribution of fishes is the result of long-continued action of forces still in operation. The species have entered our waters in many invasions from the Old World, or from the sea. Each species has been subjected to the various influences implied in the term natural selection, and under varying conditions, its representatives have undergone many different modifications.

Each of the 600 species we now know is making every year inroads on territory occupied by other species. If these colonies are able to hold their own in the struggle for possession, they will multiply in the new conditions and the range of the species will become widened. If the surroundings are different new species or varieties may be formed in time and these new forms may again invade the territory of the parent species. Again colony after colony of species after species may be destroyed by other species or uncongenial surroundings.

The ultimate result of centuries on centuries of the restlessness of individuals is seen in the facts of geographical distribution. Only in the most general way can the history of any species be traced. Could we know it all, it would be as long and as eventful a story as the history of the colonization and settlement of North America by immigrants from Europe.

By the fishes each river in America has been a hundred times discovered; its colonization a hundred times attempted. In these efforts there is no

co-operation. Every individual is for himself, every struggle is a struggle of life and death. Each fish is a cannibal, and to each species each member of every other species is an alien and a savage. Now all this has a practical side to it, although the practical side has been as yet little developed.

A leading feature of the work of the Fish Commissions must be to help the fishes over the barriers, to assist nature in the direction of colonizing streams and lakes with fishes which are good to eat, to the exclusion of the kinds of which man can make no use.

This help may be given by the introduction of vigorous kinds of fishes into waters into which they had been unable to find an entrance before. The work judiciously done may be of the greatest value to the people of our country. Numerous as are the food fishes of the Mississippi valley, it must be confessed that the rank of the great bulk of them is not high. Our rivers ought to raise something better than suckers, paddle-fish, drum and buffaloes. To bring in better fishes with success, it is necessary for us to know something of the habits and necessities of the species in question, and also something definite as to the character of the waters which are to be stocked. It is of no use to plant brook trout in a muddy bayou, or channel-cat in mountain springs of ice-water, or codfish in Lake Michigan.

Most of our information in these respects is still very vague, and most attempts at the introduction of species into new waters are still of the most haphazard sort. The recent series of examinations of the Michigan lakes, lately undertaken by the Michigan State Fish Commission, ought to yield some results in this connection, yet as the character of the waters of the state is essentially uniform, what is true of one of the little lakes in the way of supporting fish life, must be largely true of all. For this reason, desirable as an extended exploration is from an economic standpoint, it can be made more important to the science of ichthyology, than to the art of fish-culture. To ichthyology, as has been said, a sculpin is as valuable as a codfish, but fish-culture prefers the codfish.

The results of a careful survey would give us facts regarding the distribution of minnows, darters and sunfish, facts of the greatest interest and importance in science, but of no value to fish-culture to which one minnow is as good as another and both useful only as food for bass, still a thorough survey in the hands of intelligent men, of the waters of any region cannot fail to throw much light on the habits and needs of the various food fishes, and we shall look with much interest for the final results of the work in Michigan.

The other work of the Fish Commission is in the direction of fish-hatching, the protection of the young of valuable kinds until they are able to take care of themselves. The value of this work is most great, now fortunately beyond question, and its methods are reaching a high degree of perfection.

I need only say that my deepest interest in science lies in the direction of the question of the distribution of organisms and in their adaptation to their surroundings and I should be glad if I were able to contribute even a little to making our knowledge of this subject practicably available in the direction of causing two big fish to grow where one little one grew before.

Indiana State University, Bloomington, Ind.

THE COMMON FISH.

BY DR. J. C. PARKER.

It is very natural that the better varieties of fish should first receive the attention of fish culturists, but when the best method of conducting the hatching of these becomes settled, attention will be called to those commonly called "soft fish," such as the much abused "sucker," "bull-head," "perch," "rock bass," "croppie," "sturgeon," in fact, all of the native fish that furnish good and wholesome food to a large number of people throughout the state. The value of the common sucker as a food fish is but little understood or appreciated. In the early spring—at the spawning season—hundreds of thousands of these are caught in nearly all the waters of the state, furnishing many tons of very good food to the inhabitants. But the increased fishing for them in all manners of ways, from hook and line to spear and net, and at a time when to kill them is to kill the production for the year, together with the obstructions placed in the way of their reaching their spawning grounds by the numerous dams that span the rivers and creeks they frequent, is telling upon the production very rapidly, and unless some method of artificial culture shall be instituted they will become a thing of the past, with nothing better to take their place. Feeding as they do, upon the low forms of life that exist at the bottom of the waters they inhabit, they abstract nothing from the common weal, as do the more rapacious varieties met. In fact it is doubtful if some of these rapacious varieties, as the pike, perch, black bass, etc., could exist in any considerable numbers if it were not for the prolific nature of these commoner forms of fish life. Nature always strikes an even balance, and if any special variety of animal or vegetable life is obliterated or curtailed it has a corresponding effect upon some other form of life that depends upon the intercepted form for support or maintenance; and in too many cases these often controllable causes, through human agency, are neglected or overlooked until too late to remedy. At present this waste is not apparent in any varieties of fish that are propagated and planted by the fish-culturists, but it would seem to be the part of wisdom to pay some little attention to these side issues before they become the main ones. New forms of food are being constantly evolved from all food products, and noticeably so from the fish. For instance, the enormous industry that has been inaugurated in the canning of salmon, the

production of the "American sardine" from the once worthless Menhaden are striking instances of the value of some forms of modern fish industries, and in our own state to-day one of the most valuable of commercial fish is the worthless sturgeon of a few years ago, and so assiduously is it sought for that the supply will become exhausted in a very short time unless the fish-culturist comes to the rescue. Some experiments looking towards a successful way in which their artificial propagation may be carried forward has been instituted with a fair prospect of success, and it is the desire of this commission to spend as much time and money upon this interesting variety as is possible without neglecting the more prominent work of the commission. The common bullhead is one of the best varieties of our common fish, and its value as a food fish has been greatly under-rated; living and thriving in all of our small inland lakes, and caught by the "small boy" with a pin hook, it has become a synonym for low stupidity, when in fact its protection and care of its young is one of the marvels of fish life, and there is hardly a doubt but that if the same intelligent cultivation could be carried on with this fish as there has been with the carp surprising results would be obtained.

Persons throughout the state are constantly calling on the commission to furnish them with fish for waters in their vicinity, when, in many instances, the waters already hold better fish for the localities than any the commission could furnish. One of the most important things for the general public to know is the value of neglected things right at their own doors.

The indiscriminate capture and destruction of every kind of fish at all seasons and in any manner is a constant and crying evil that can only be remedied when the general public can be brought to see that it is a subject that concerns every one, and more especially the poorer classes, who have not the money to purchase luxuries that are really in their hands already, or might easily be if the proper laws were made and enforced.

NO 11.—REPORT OF THE FISHERY COMMITTEE OF THE HOUSE OF REPRESENTATIVES IN THE SESSION OF 1887.

By unanimous consent, the committee on fisheries reported as follows:

The undersigned committee on fisheries beg leave to report that in accordance with custom they, during the vacation of the session in the month of February, visited the fish stations of the state located at Detroit, county of Wayne; Paris, county of Mecosta; and Petoskey, county of Emmet.

On February 7, 1887, your committee on fisheries met at the office of the State Board of Fish Commissioners, located at Detroit, and were shown the accounts of said board and the manner of the keeping of the same; also the method of gathering statistics regarding the interest of the state in fish and fisheries, together with all the facts regarding the labors of said commission in any way pertinent to the interest of the state. In this connection we would state that it is the object of the commission to propagate and cultivate fish for the purpose of planting in the inland lakes and streams; and in the bays, harbors and chain of great lakes of the state, so far as its jurisdiction extends, and to take such steps and use such action as will best promote and preserve the fish industry of the state, under the powers delegated to them by law.

In order that your honorable body may be made better acquainted with the details of this item of trade, your committee would state that the catch of the fishermen of Michigan amounted in the past year to nearly 26,400,000 pounds, yielding to the parties so engaged not less than $800,000, employing over seventeen hundred persons, sixty-six steam tugs, three hundred and eighteen sail boats, two hundred and thirty-two pound net boats, and one hundred and sixty-five skiffs.

The value of nets, boats, docks and buildings engaged in this traffic is estimated at $1,100,000.

We would also state that the territory of the fishing grounds within the jurisdiction of the state, in the great lakes, amounts to 30,000 square miles, or an area equal to three-fifths of the total land area of the State; that the coast line extending along the east and north shores of Lake Michigan, the south shore of Lake Superior, the north and west shores of Lake Huron, and the shores of Lakes St. Clair and Erie is over two thousand miles in length. The coast line so designated is totally exclusive of any of the inland waters of the state, and is given for the purpose of calling the attention of the members of the legislature to the facts in the case, and of enlisting their attention and support in behalf of this industry.

DETROIT STATION.

Visiting this station your committee found a commodious wooden building, in size forty by eighty feet, consisting of a main room and office, with storage room attached, devoted to the sole purpose of the propagation and hatching of whitefish.

Its capacity is 50,000,000 annually, and it was estimated at the time of our visit that 40,000,000 eggs were in process of hatching. Of this number it is believed that not more than ten per cent will fail to mature while in process of incubation.

Whitefish eggs hatch in the months of March and April, and as soon as the young fry are in readiness they are placed in cans provided for the purpose of transporting them, and forthwith distributed and planted in the various waters of the state, according to the orders received by the commissioner for them.

From this station of Detroit alone there were sent out for distribution and planted during the season of 1886, 36,420,000 whitefish. These were planted in the waters of Lakes Michigan, Huron, St. Clair, Traverse and Saginaw Bays, Detroit river and some of the inland lakes.

Mr. Eli Tinlan is the overseer of this station, and your committee report it complete in its appointments, and faithfully, competently and economically carried on.

PARIS STATION.

This fish hatchery is situated on the Grand Rapids & Indiana Railroad, in the county of Mecosta, and at present is used exclusively for the propagation of brook trout. It comprises 118 acres of land, traversed by two streams, named Cheney and Little Buckhorn creeks, respectively. It is equipped with a hatchery, and a superintendent's and overseer's house. These streams empty into the Muskegon river. Along Cheney creek several fish ponds have been formed in which many thousands of stock brook trout are kept for breeding purposes. The hatchery has a capacity of 1,500,000 brook trout per annum, and when visited by your committee 1,300,000 young trout were beginning to hatch out.

Mr. O. D. Marks is the overseer of this station, and everything connected therewith exhibited knowledge, care, and attention. From this station during the season of 1886, 719,000 brook trout were hatched and distributed for planting.

PETOSKEY STATION.

This station is used for the hatching of whitefish, and is situated on the line of the Grand Rapids & Indiana railroad, on the shores of Little Traverse Bay, in the county of Emmet. The capacity of this station is 33,000,000 whitefish per annum. It is well managed by Mr. A. W. Marks, as overseer; comprises a hatchery and residence, and in this season (of 1887) will plant about 25,000,000 whitefish.

GLENWOOD STATION.

This station, situate in Cass county, is used for the propagation of carp. Your committee have not as yet had time to visit it, and therefore have no report to make concerning it.

IMPROVEMENTS.

1. Your committee recommend the building of a platform and veranda extending across the front of the Detroit hatchery building, made necessary as a suitable approach and protective shade.

2. The building of a second hatchery house at Paris station, and making the different improvements suggested in the estimates of the board herewith attached, for the reason that the facilities of said station will readily admit of the propagation of 5,000,000 brook and other trout annually with very slight additional expense to that now incurred, together with the fact that the orders received from all parts of the state for trout fry for planting being far in excess of the supply, and in excess of the capacity of the present hatching building, warrants the committee in recommending more room and increased capacity.

In conclusion, your committee desire to say that whenever opportunity offered, they made inquiry into the results of fish planting, and we were assured by many practical, observing persons that in the great lakes, and in the inland lakes where whitefish have been planted, the most gratifying results are to be seen, and that in the many inland streams where brook trout have been planted they have thrived and grown in the most satisfactory manner.

We wish to say too, that the board of fish commissioners are gentlemen devoted to their work, who give a large share of their time, without pay, as good citizens to this work, and as a result of our investigations we would recommend that the appropriations asked for by them, of this legislature, may be granted.

E. Z. PERKINS,
Chairman.

TABLE A.—*Whitefish Plants, 1887, from Petoskey House.*

Name of Waters.	Where Planted.	Date.	Number.
Lake Michigan	Petoskey	March 6	3,168,000
Pine Lake	East Jordan	" 19	3,000,000
Torch Lake	Spencer Creek	" 25	3,250,000
Mullet Lake	Topinabee	" 29	3,250,000
Burt Lake	Indian River	" 31	3,000,000
Straits of Mackinac	Mackinaw City	April 1	4,000,000
Traverse Bay	Traverse City	" 2	4,000,000
Traverse Bay	Charlevoix	" 2	3,000,000
Lake Michigan	Petoskey	" 2	4,160,000
Total			30,828,000

TABLE A.—CONTINUED.—*Whitefish Plants, 1888, from Petoskey House.*

Name of Waters.	Where Planted.	Date.	Number.
Little Traverse Bay	Petoskey	February 25	3,000,000
Little Traverse Bay	Petoskey and Harbor Springs	March 10	3,500,000
Straits of Mackinac	Mackinaw City	" 12	4,000,000
Straits of Mackinac	Mackinaw City	" 15	4,000,000
Lake Michigan	Charlevoix	" 17	3,000,000
Straits of Mackinac	Mackinaw City	" 19	4,500,000
Little Traverse Bay	Petoskey	" 25	7,968,000
Total			29,968,000

TABLE B.—*Whitefish Plants, 1887, from Detroit House.*

Name of Waters.	Where Planted.	Date.	Number.
Lake Michigan	Ludington	April 11	5,145,000
Lake Michigan	South Haven	" 13	4,480,000
Lake Michigan	Manistee	" 13	5,110,000
Lake St. Clair	Grosse Point	" 15	2,500,000
Lake Michigan	Grand Haven	" 16	6,501,000
Lake Michigan	Frankfort	" 18	3,630,000
White Lake	Montague	" 19	4,500,000
Lake Huron	Oscoda	" 21	3,630,000
Lake St. Clair	Mill Creek	" 22	3,360,000
Saginaw Bay	Bay City	" 25	3,300,000
Total			42,156,000

TABLE B.—CONTINUED.—*Whitefish Plants, 1888, from Detroit House.*

Name of Waters.	Where Planted.	Date.	Number.
Lake Michigan	St. Joseph	March 26	4,000,000
Lake St. Clair	Grosse Point	" 28	5,000,000
Lake Michigan	Ludington	" 30	4,000,000
Lake Erie	Monroe	April 9	4,000,000
Lake Michigan	South Haven	" 10	4,000,000
Detroit River	Fort Wayne	" 13	5,000,000
Lake Michigan	Manistee	" 15	4,000,000
Traverse Bay	Traverse City	" 17	4,000,000
Lake Michigan	Muskegon	" 20	4,000,000
Lake St. Clair	Grosse Point	" 25	5,000,000
Total			43,000,000

TABLE C.—*Brook Trout Plants, 1887.*

County and Name of Waters.	Town.	Name of Depositor.	Date of Deposit.	Number.
Allegan County:				
Private pond	New Richmond	C. Whitney	April 1	5,000
Silver creek	Plainwell	E. J. Anderson	February 21	12,000
Red run	Dorr	R. J. Barrie	" 21	5,000
No name	New Richmond	M. J. Nixon	" 21	2,000
Bear creek	Allegan	H. B. Peck	" 21	7,000
Rabbit river	Martin	Isaac Page	" 21	2,000
Alcona County:				
E. W. and Mid. branch of Killmaster creek	Killmaster	A. Backus	March 28	25,000
Pine creek	Harrisville	S. B. Anges	" 28	5,000
Mill creek	Harrisville	L. A. Colwell	" 28	5,000
Antrim County:				
Jordan river	Alba	Fish Commission	April 19	20,000
Arenac County:				
Gilbert and Meadow creeks	Sterling	P. Gilbert	March 23	5,000
Barry County:				
----------	Hastings	C. Rogers	" 4	10,000
Berrien County:				
No name	Coloma	L. Muth	April 1	3,000
Branch County:				
No name	Union City	W. H. Hubbard	March 4	5,000
Calhoun County:				
Wandogo, Fendam and Bear creeks, and Gass, Crooked, Hicklin, Bullis, Meads and Ways brooks	Battle Creek	N. A. Osgood	" 16	53,000
Tekonsha Creek	----------	A. D. Eldred	" 31	10,000
Cass County:				
Dowagiac river	Dowagiac	F. J. Mossier	" 11	10,000
Spring, Battle and Red Run creeks	Glenwood	W. Wells	" 11	10,000
Charlevoix County:				
Nudman and Stone creeks	Charlevoix	L. D. Bartholomew	" 11	15,000
Boyne river	Boyne	Fish Commission	April 11	50,000
Cedar river	Boyne	Fish Commission	" 19	20,000
Antrim, VanAnnan's and Inwood creeks	----------	G. H. VanPelt	" 19	25,000
Cheboygan County:				
Topinabee river	Topinabee	H. H. Pike	" 27	10,000
Clare County:				
Walker creek	Farwell	C. Bellows	March 3	10,000
Middle branch Tobacco river	Harrison	W. W. Green	February 25	10,000
N. and S. br. of Tobacco river	Clare	S. Keller	" 23	20,000
Eaton County:				
Sandstone creek	Grand Ledge	C. Holmes	March 21	5,000
Emmet County:				
Horton's creek	Petoskey	A. W. Marks	" 11	10,000
Bear creek	Grand Rapids	J. M. Metheany	" 19	5,000
Genesee County:				
Yellow creek	Argentine	W. H. Johnson	" 18	5,000
Cherry creek	Linden	A. Shotwell	" 18	2,000
Gladwin County:				
Howland, Bush and Spring creek	Gladwin	F. L. Pringle	" 14	20,000
Grand Traverse County:				
Dood's creek	Traverse City	L. Doods	April 22	5,000
Ingham County:				
Sycamore creek	Mason	M. D. Chatterton	March 16	10,000

TABLE C.—*Continued.*

County and Name of Waters.	Town.	Name of Depositor.	Date of Deposit.	Number.
Ionia County:				
Clear creek	Ionia	M. R. Wager	March 9	3,000
Spring brook	Belding	John Bond	" 9	3,000
Stoney creek	Hubbardston	G. A. Chatterton	" 9	5,000
Isabella County:				
	Sherman City	M. G. Tinker	" 25	5,000
Rat-tail creek	Sherman City	E. Baker	" 25	5,000
Cedar creek	Sherman City	K. Butts	" 25	5,000
South br. Little Salt creek, North br. Little Salt creek	Mt. Pleasant	H. Burr	May 13	20,000
Chippewa river	Union	Sanford Keeler	February 23	5,000
Kalamazoo County:				
Comstock creek	Comstock	P. A. Peer	March 16	5,000
Spring creek	Vicksburgh	G. W. Chamberlain	" 16	5 000
Portage creek	Climax	F. Hogman	" 4	10,000
Tributary to Portage creek	Galesburg	A. H. Hubbard	" 16	10,000
Tributary to Kalamazoo river	Kalamazoo	C. S. Dayton	" 21	3,000
Pine creek	Kalamazoo	H. L. Sleeper	" 21	10,000
Big Portage creek	Kalamazoo	W. A. Glover	April 4	5,000
Spring run	Vicksburgh	C. Lemon	" 4	3,000
Hasho run	Vicksburgh	C. H. McKain	" 4	3,000
Kalkaska County:				
Rapid and Boardman rivers	Kalkaska	F. R. Boyd	March 25	15,000
	Kalkaska	Fish Commission	April 11	20,000
Kent County:				
Turner, Kellogg, and Butternut creeks	Grand Rapids	B. J. Laraway	February 23	10,000
Sillway and Balls creek	Kent City	J. S. Toyer	" 28	10,000
Herald and Crockery creek	Casnovia	E. Farnham	" 28	10,000
Hawn Creek	Lowell	F. O. Taft	March 16	5,000
Bear, Cranston and Baker creeks	Rockford	N. McMillen	" 18	5,000
White, Spring, Duke, Cedar, Butternut and Crimion creeks	Cedar Springs	C. S. Ford	" 18	40,000
Smith's creek	Sand Lake	C. A. Green	" 18	5,000
Rush, Boyer, Indian and Sand creeks	Grand Rapids	L. S. Hill	" 26	10,000
Walker and Kenyon creeks	Lowell	E. Dodge	April 1	5,000
Lake County:				
Ram, Sweetwater, King and Sanborn creeks		Sanford Keeler	February 23	15,000
Lapeer County:				10,000
Hunters creek	Lapeer	S. N. Vincent	March 28	15,000
South Branch of Flint river	Metamora	Ira Reed	" 28	
Lenawee County:				10,000
Howell creek	Tecumseh	C. E. Triplet	" 7	
Livingston County:				
Dibble creek	Howell	J. E. Dibble	" 9	3,000
Dibble creek	Howell	C. G. Jewett	" 9	3,000
Manistee County:				
Chief creek	Chief	J. M. Kerry	February 28	3,000
Mecosta County:				
Dalzell and Spring creeks	Paris	J. Lain	March 4	2,000
Bull Kill creek	Paris	J. Bisbee	" 4	2,000
Beaver Dam creek	Altona	S. F. Fryor	" 21	5,000
Brockway & Quingley creeks	Rustford	C. M. Helms	" 21	10,000
Cedar creek	Stanwood	C. F. Barnard	" 16	5,000
Branch of Pine river	Millbrook	L. D. Decker	" 21	5,000
Minnehaha, Millar, Clear, and Kigooni creeks	Paris	Fish Commission	April 14	20,000
King creek	Big Rapids	J. S. Smith	" 4	5,000
Fogry run	Big Rapids	W. L. P. Elmer	" 4	5,000
Cheney creek	Paris	W. D. Marks	" 6	5,000
Buckhorn creek	Paris	W. D. Marks	" 6	5,000
Parish creek	Paris	W. D. Marks	" 6	10,000
Brush creek	Big Rapids	D. McLinn	" 26	5,000
Hudnutt and Mitchel's creeks	Big Rapids	J. Hudnutt	" 26	5,000
Mitchel's creek	Big Rapids	— Pierce	May 4	5,000

TABLE C.—*Continued.*

County and Name of Waters.	Town.	Name of Depositor.	Date of Deposit.	Number.
Montcalm County:				
Pierson creek	Pierson	A. H. Saur	March 18	5,000
Fish creek	Stanton	D. A. Briant	April 22	10,000
Hemingway creek	Stanton	A. M. Hempstead	" 22	5,000
Muskegon County:				
No name to stream	Muskegon	O. M. Field	March 14	5,000
Tributary to Crockery creek	Trent	H. Gilbert	" 16	5,000
Green, Black and Bear creeks	Muskegon	C. S. Gunn	" 26	20,000
Newaygo County:				
Robbins, Dowling, Wilcox and Bigelow creeks	White Cloud	P. M. Rodell	February 23	15,000
David's creek	Woodville	S. J. Wright	" 23	5,000
Holmes and Pennoyer creeks	Newaygo	E. O. Shaw	" 28	25,000
Spring creek	Sun P. O.	H. Marvin	April 1	5,000
Ogemaw County:				
No name	West Branch	D. Wight	March 21	10,000
Oakland County:				
Sand and Andrews creeks	Highland	H. S. Holdridge	" 18	5,000
Oceana County:				
McGill's creek	Hesperia	G. McGill	February 23	5,000
Pentwater river, Judy and Farnum creeks	Hart	E. D. Richmond	March 14	25,000
Osceola County:				
Coles and Turns creeks		Sanford Keeler	February 25	10,000
West branch Clear river	Marion	W. H. Fisk	March 4	10,000
No name	Ashton	George Rice	" 19	2,000
Ottawa County:				
Cedar and Kelley's creeks	Berlin	S. D. Marvin	" 18	5,000
Private pond	Jamestown	G. F. Richmond	" 18	5,000
Roscommon County:				
N. W. and main branch of Sugar river		Wells, Stone & Co.	" 18	20,000
Saginaw County:				
Allison and Works creeks	East Saginaw			10,000
St. Clair County:				
Tributary to Mill creek	Brockway	Wm. Mason	March 28	2,000
Shiawassee County:				
Three Mile creek	Durand	M. S. Smith	" 4	10,000
VanBuren County:				
Loomis brook	Bloomingdale	A. J. Loomis	February 21	5,000
Boys' Spring brook	Mattawan	J. W. Clark	March 7	2,000
Day's creek	Lawton	C. F. Day	" 11	3,000
Paw Paw river	Paw Paw	C. Engle	" 11	5,000
Butternut creek	S. Haven	J. C. Merson	" 21	5,000
Paw Paw river	Paw Paw	S. Hawkins	" 11	5,000
Washtenaw County:				
Bull and Mill creeks	Chelsea	R. Kempf	" 9	10,000
Harny creek	Ann Arbor	R. Kempf	" 9	10,000
Paint creek	Ypsilanti	J. E. Bassett	" 9	10,000
Paint creek	Manchester	F. J. Williams	" 23	5,000
Wayne County:				
No name given	Detroit	Edgar Weeks	May 24	2,000
Total				1,090,000

TABLE D.—*Brook Trout Plants, 1888.*

County and Name of Waters.	Town.	Depositor.	Date.	Number.
Allegan County:				
Silver creek	Plainwell	Ed. J. Anderson	Feb. 27	8,000
Black creek	Burnips Corners	Francis J. Buege	" 6	8,000
Miner creek	Albronia	Allen Dunfield	" 6	8,000
Laraway's creek	Shelbyville	D. D. Harris	March 23	8,000
Mineral Spring brook	Saugatuck	F. A. Winslow	" 27	4,000
Alpena County:				
Avery's creek	Alpena	Burton & McRae	" 31	12,000
Antrim County:				
Jordan river		Fish Com.	April 12	30,000
Branch County:				
Ox creek	Benton Harbor	H. H. Portman	Feb. 20	6,000
Sutton's creek	" "	"	" 20	5,000
Eastman creek	" "	"	" 20	5,000
Yellow creek	" "	C. Colby	" 20	4,000
Hog creek	" "	"	" 20	4,000
Piperton creek	" "	"	" 20	4,000
Blue Creek	" "	"	" 20	4,000
Dunk's Creek	Union City	J. W. Dunks	" 27	3,000
Meseroll's Creek	" "	L. L. Hursh	March 26	4,000
Barry County:				
Walker's Creek	Middleville	John McQueen	" 19	4,000
Walton creek	Freeport	John S. Walton	" 19	4,000
Calhoun County:				
Rice creek	Marshall	Thomas L. Cronin	" 1	12,000
Woodworth creek	Athens	Geo. M. Ferris	" 28	4,000
Bear creek	Marshall	F. H. Wherry	April 2	20,000
Wilder creek	"	"		
Ferris creek	Athens	Geo. M. Ferris	March 28	4,000
Clare County:				
Head of Chippewa river	Crooked Lake	C. H. Bates	" 5	4,000
South Br. of Tobacco, Little Tobacco and Spring Brook	Clare	Ebenezer Perry	" 5	16,000
North Br. of Tobacco river	Harrison	W. W. Green	" 28	16,000
Cheboygan County:				
Silver creek	Wolverine	Geo. A. Mullholland	April 3	4,000
Cold Spring creek, Little Bear creek	Rondo	W. H. Merrett	" 3	4,000
Cass County:				
No name	Cassopolis	J. P. Smith	March 12	8,000
Mechanicsburg creek	"	Robt. H. Wiley	" 12	8,000
No name	"	Chas. W. Clisbee	" 12	8,000
Kinsey's creek	Barron Lake	B. D. Shaw	" 12	8,000
Clinton County:				
Hayworth creek	St. Johns	John Silvers	" 19	8,000
Charlevoix County:				
Newman creek, Monroe creek	Charlevoix	L. D. Bartholemew	" 28	16,000
Cedar river		Fish Com.	April 12	25,000
Boyne river		"	" 12	25,000
No name	Norwood	A. W. Van Pelt	March 28	12,000
Crawford County:				
No name	Grayling	A. C. Babbitt	April 5	4,000
Eaton County:				
Carrier creek	Delta	Waterman Larzelere	March 12	8,000
Emmet County:				
Davis Spring brook	Petoskey	James Z. Davis	" 28	4,000
Bear creek	"	Clay E. Case	" 28	4,000
Peble creek	"	H. C. Rose	" 28	1,000
Horton creek	"	Isaac Stauffier	" 28	12,000
Dutton's creek	Harbor Springs	Isaac Dutton	" 28	4,000
Carp Lake		Fish Com.	April 12	30,000
Genesee County:				
Lewis creek	Argentine	Wm. H. Johnson	March 19	8,000

TABLE D.—*Continued.*

County and Name of Waters.	Town.	Depositor.	Date.	Number.
Grand Traverse County:				
Cedar river	Traverse City	L. M. Thomas	March 30	12,000
Mitchel's creek	" "	J. M. Meatheany	" 23	15,000
Hillsdale County:				
Sand creek	Litchfield	Melton Horning	" 16	8,000
Ionia County:				
Spring brook	Lyons	Lewis C. Faxon	" 12	4,000
No name	Portland	U. J. Maynard	" 12	4,000
Mill creek	Saranac	A. W. Huntley	" 19	8,000
Beckwith creek	"	L. C. Walker	" 19	4,000
Stoney and Loss brook	Pewamo	F. C. Hathaway	" 19	8,000
No name	Palo	W. J. Hargrave	" 19	4,000
Ingham County:				
Stream emptying into Pine creek	Lansing	Henry S Sleeper	" 23	4,000
Iosco County:				
Cold creek	Tawas City	N. C. Hastings	April 2	30,000
Sims creek				
Silver creek				
Tawas creek				
Porterfield creek	Whittemore	Frank Duplantz	" 2	8,000
Isabella County:				
Darrow creek	Mt. Pleasant	George Granger	" 16	16,000
Big Cedar creek				
Jackson County:				
Conner creek	Napoleon	Charles A. Wood	March 19	8,000
Outlet of Gillet's Lake	Jackson	T. J. Conely	" 19	4,000
Snyder's creek	Manchester	C. B. Bush	" 19	4,000
Kent County:				
Butternut creek	Dutton	A. W. Blain	Feb. 24	6,000
Mound and Spring brooks	Grand Rapids	W. H. Mills	March 13	4,000
Spring brook	Sparta	Frank Baird	" 21	4,000
Sand creek	"	Norman Harris	" 21	12,000
South Crockery creek	Casnovia	E. Farnham	" 21	4,000
Bell creek	"	E. Farnham	" 21	4,000
Bell creek	"	Wm. M. Fenton	" 21	4,000
Duck creek	Kent City	A. H. Saur	" 21	4,000
Graves' creek	Kent City	W. D. Wing	" 21	4,000
County Line creek	Sand Lake	J. V. Crandell	" 26	4,000
Smith's Spring creek	Sand Lake	Chas. A. Green	" 26	8,000
Porter creek	Cedar Springs	W. W. Burch	" 26	8,000
Blair brook	Grand Rapids	Philo T. Peck	" 27	4,000
Whiskey and Buck creeks	" "	B. J. Laraway	" 27	4,000
Coldwater Creek	" "	H. W. Davis	" 27	12,000
Lamberton Creek	" "	B. R. Pierce	April 2	4,000
Dopp, Duke, Cedar, White Spring, Little Cedar, Butternut and Crimion creeks	Cedar Springs	C. S. Ford	March 26	20,000
Kalamazoo County:				
Knight's creek	Schoolcraft	Henry W. Moyer	" 12	12,000
Shafer creek	Kalamazoo	Wm. A. Glover	" 23	12,000
Parker creek				
Leeper creek				
Lillies creek	"	E. S. Shafer	" 23	4,000
Porter creek	"	Morris Gibbs, M. D.	" 23	8,000
Robes creek	"	J. E. Doyle	" 23	4,000
Gun creek	Galesburg	Charles A. Cory	" 23	4,000
Campbell's creek	"	A. H. Hubbard	" 23	4,000
Will's creek	Schoolcraft	Thos. Hewett	" 26	4,000
Black river	"	John Hartman	" 26	4,000
Kalkaska County:				
Boardman river		Mich. Fish Com.	April 12	30,000
Livingston County:				
Ore creek	Brighton	B. T. O. Clark	March 12	16,000
Butternut creek	Tyrone	Elmer Cranston	" 19	4,000
Lenawee County:				
Fairy Dale brook	Adrian	Heman Loomis	" 19	12,000

TABLE D.—*Continued.*

County and Name of Waters.	Town.	Depositor.	Date.	Number.
Lake County:				
Piquette creek	Wingleton	W. D. Wing	March 21	4,000
Headq'rters of Pere M. River	Chase	—Fowler	" 23	2,000
Lapeer County:				
Pine creek	Metamora	L. Y. Struble	April 18	8,000
Mecosta County:				
E. Br. of Muskegon river	Mecosta	R. S. Woolford	March 10	6,000
Pointer creek	"	" " "	" "	6,000
Poney creek	"	Geo. Minkle	" "	4,000
Town Line creek	"	" "	" "	4,000
Pointer creek	"	" "	" "	4,000
Russell creek, Stoney creek, Brush creek, Burney creek, Scott creek, Gill creek	Morley	James C. Boyd	" 26	30,000
Cedar creek	Stamwood	C. F. Barnard	" "	4,000
Buckhorn creek	Paris	Fish Com.	" 27	8,000
	"	C. Fortine	" 29	2,000
Hyde creek	Big Rapids	Wm. Laduer	April 7	8,000
Davis creek	Rustford	W. J. Griffin	" "	8,000
Seaton creek	Altona	George Kirby	" "	4,000
Rattail creek	Fork	E. R. Sage	" 16	12,000
Paris creek		Fish Com.	" 12	10,000
Mack's creek	Big Rapids	H. E. Hardy	" 5	5,000
Montcalm County:				
Tamerack creek	Lakeview	A. T. Call	March 10	16,000
Town Line creek	Coral	J. A. Barry	" 12	8,000
Indian creek, Tamerack creek, Church creek	Howard City	C. E. Murray	" 26	20,000
Cedar and Town Line creeks	Edmore	A. E. Hunter	" 31	12,000
	Greenville	Leroy Fuller	" 31	8,000
S. Br. of Fish creek	Sheridan	Ephraim Follet	" "	8,000
Fish and Trib. to Fish creek	Stanton	C. F. Brant	" "	8,000
Macomb County:				
E. Br. of Stoney creek	Romeo	Ed. T. Morton	" 12	8,000
N. Br. of Clinton river	"	" " "	" "	8,000
Wilson's creek	Washington	Andrus & Stewart	" "	4,000
Mason County:				
Sable river	Free Soil	C. A. Tobey	" 15	16,000
Cedar creek	Custer	Edward Stork	" 21	6,000
Black creek	"	" "	" "	6,000
Swan creek	Riverton	J. Griffin	" "	5,000
Micco creek	"	" "	" "	5,000
Quinn creek	"	" "	" "	5,000
Reid creek	"	" "	" "	5,000
Lincoln creek and Little Sable	Fountain	Dodge Squire	" "	20,000
Manistee County:				
No name	Onekama	A. W. Farr	" 15	4,000
"	"	Fred Culver	" "	4,000
Onekama Spring brook	"	Chas. Secor	" "	4,000
Chief creek	Chief	Peter Schneider	" "	4,000
Clay Bank and Pine creek	Eastlake	T. A. Brown	" "	12,000
Muskegon County:				
Cleveland and Silver creeks	Whitehall	E. M. Ruggles	" "	12,000
Marquette County:				
Silver creek, Lake Sally, North lake	Ishpeming	Geo. A. Newitt	April 8	20,000
Pijike (in Indian) sometimes called Pishike river	Michigamme	J. C. Fowle		20,000
Newaygo County:				
Holmes brook and Penoyer creek	Newaygo	E. O. Shaw	March 7	16,000
Upper Pere Marquette	W. Troy Junction	Albertus Andrus	" 3	6,000
Freeman creek	" " "	" "	" "	5,000
Pickerd creek	" " "	" "	" "	5,000
S. Br. of Pere Marquette	Lilley	E. Britley	" "	16,000

TABLE D.—*Continued.*

County and Name of Waters.	Town.	Depositor.	Date.	Number.
Minnie creek	Denver	P. H. McGhan	March 17	8,000
Gulley creek	Bridgeton	M. V. Barton	" 21	4,000
Minnie creek	"	" " "	" "	4,000
Utley creek	Newaygo	Stephen D. Thomps'n	" "	4,000
Alley creek	Ensley	B. Ensley	" 26	4,000
Holmes creek	Newaygo	Newaygo	" 21	4,000
Ottawa County:				
Deer creek	Cooperville	D. O. Watson	" 5	12,000
Spring creek	Talmadge	Peter Malone	" 27	4,000
Oceana County:				
Branch of Stoney creek	Shelby	E. J. Shirts	" 15	8,000
Baldwin creek	Hart	E. D. Richmond	" "	8,000
Ward's creek	"	" " "	" "	6,000
Roby creek	"	" " "	" "	6,000
Utley creek	Hesperia	Ephraim Utley	" 17	8,000
N. Br. of White river	"	Donald McClarren	" "	12,000
Ritcherson's creek	"	Frank Utley	" "	4,000
Osceola County:				
McDonald's creek	Reed City	E. L. Hayes	" "	8,000
Norway creek	Evart	Allen Campbell	" 23	8,000
W. Br. of Clam river	Marion	E. W. Chapin	April 5	12,000
Middlebranch river	"	C. Clark	" 6	12,000
Mid. Br. of Muskegon river	"	Fred R. Grice	" 6	12,000
Oakland County:				
No name	Birmingham	S. Alexander	March 19	4,000
Indian Garden Lulie brook	Milford	E. Bissell	April 24	15,000
Ogemaw County:				
Wilkins' creek, Rust creek, Stockade creek	West Branch	A. S. Rose	April 3	30,000
Spring brook	" "	Geo. L. Lamb	" 5	4,000
West Br. and Klacking creek	" "	J. C. Crabtree	" "	4,000
Hdqrs. of W. Br. of Rifle river	" "	Robert Petit	" "	4,000
Chapman creek, Edward's creek, W. Br. of Edward's creek, W. Br. of Tittabawassee river	" "	S. V. Thomas	" "	30,000
Silver creek	" "	C. M. Corning	" "	8,000
Spring creek	Greenwood	C. N. Ashford	" 2	8,000
Saginaw County:				
Md. Br. of Pere Marquette, Sanborn creek, Sweetwater creek, Cole's Crossing, Kinny's creek, Br. of Tobacco river, Trom creek	East Saginaw	Sanford Keeler	January 19	40,000
Van Buren County:				
Spring and Day creek	Lawton	C. F. Day	February 29	8,000
No name	"	Wm. H. Stanton	" "	3,000
No name	Almena	M. F. Miner	" "	4,000
Hayden's creek	"	George Langdon	" "	4,000
Cold Spring brook	Paw Paw	Frank C. Thomas	" "	4,000
E. Br. of Paw Paw river	" "	Seward Hopkins	" "	4,000
Pine creek	Hartford	A. H. Young	March 27	12,000
Wexford County:				
W. Br. of Clam river, N. fork of W. Br. of Clam river, N. Br. of Pine river	Cadillac	M. S. Cornwell	" 17	20,000
Hopkin's creek and Little Manistee	Manton	H. S. Lamb	" "	12,000
Washtenaw County:				
Hall's creek, Basset creek, Lashier creek	Saline	Edgar R. Aldrich	February 22	16,000
Paint creek	Ypsilanti	A. H. Martin	March 1	12,000
Honey creek	Ann Arbor	John F. Lawrence	" "	12,000

TABLE D.—*Continued.*

County and Name of Waters.	Town.	Depositor.	Date.	Number of Fish.
Spring brook	Manchester	F. J. Williams	March 19	4,000
Baydeo's creek	Ann Arbor	Jasper Jones	April 3	8,000
Fellow's brook				
Bond creek				
Mud creek	Saline	J. H. Battle	" 18	25,000
Spring brook				
Hoyt's brook				
Tate's creek				
				1,639,000

TABLE E.—*California Trout, 1887.*

Name of Waters.	County.	Year.	Plant.
Tributary to Muskegon River	Mecosta	1887.	20,000

TABLE F.—*Schoodic Salmon, 1887 and 1888.*

Name of Waters.	County.	Year.	Plant.
Log Lake	Kalkaska	1887	5,000
Torch Lake	Antrim	1887	18,636
Log Lake	Kalkaska	1888	12,000
Torch Lake	Antrim	1888	61,424

TABLE G.—*Plants of Wall-eyed Pike, 1887.*

County.	Name of Waters.	By Whom Delivered.	Date.	Number.
Branch	Coldwater Lake	J. B. Shipman	June 10	480,000
Eaton	Tappen's Lake	A. W. Marks	June 10	160,000
Hillsdale	Banker's Lake	A. W. Marks	June 10	160,000
Kent	Cedar Springs and Upper and Lower Black Lake	A. W. Marks	June 9	240,000
	Grand River	A. W. Marks	June 9	120,000
Kalamazoo	Indian and Barton Lakes	A. W. Marks	June 9	240,000
Lenawee	Wampler's Lake	A. W. Marks	June 10	320,000
	Sand Lake	A. W. Marks	June 10	320,000
Mecosta	Chippewa Lake	A. W. Marks	June 9	240,000
St. Joseph	Klinger's Lake	A. W. Marks	June 9	320,000
Wexford	Clam Lake	A. W. Marks	June 9	400,000
Washtenaw	Columbia Lake	A. W. Marks	June 10	160,000
Osceola	Strawberry Lake	A. W. Marks	June 9	120,000
Total				3,280,000

TABLE H.—*Plants of Wall-eyed Pike, 1888.*

County.	Town.	Name of Depositor.	Date.	Number.
Branch	Sherwood	O. L. Pierce	June 11	170,000
	Coldwater	John B. Shipman	" 14	340,000
	Quincy	A. K. Coon	" 14	136,000
Cass	Vandalia	J. M. Bonine	" 11	170,000
	Cassopolis	James Smith	" 11	500,000
	Marcellus	C. F. Jones	" 18	340,000
	Dowagiac	Eugene Larzelere	" 20	340,000
Calhoun	Tekonsha	A. D. Eldred	" 11	340,000
	Marshall	C. E. Gorham	" 16	340,000
Clare	Harrison	W. W. Green	" 18	340,000
Emmett	Cheboygan	E. Z. Perkins	" 20	340,000
Genesee	Linden	Anson Shotwell	" 1	170,000
	Grand Blanc	B. F. Bush	" 18	170,000
Hillsdale	Hillsdale	H. M. Keefer	" 14	272,000
	Pittsford	A. L. Davis	" 14	136,000
Ionia	Orleans	Benjamin Hall	" 13	102,000
Ingham	Lansing	D. B. Briggs	" 13	204,000
	Lansing	F. L. Dodge	" 13	102,000
	Lansing	John M. Potter	" 18	340,000
Jackson	Grass Lake	Wyllys R. Mohr	" 11	170,000
	Jackson	C. B. Bush	" 16	656,000
Kalamazoo	Galesburg	E. L. Hawks	" 16	340,000
	Galesburg	W. S. Kerby	" 16	340,000
	Schoolcraft	L. A. Longwell	" 20	170,000
	Schoolcraft	H. W. Moyer	" 20	170,000
	Schoolcraft	T. Hewitt	" 20	170,000
	Schoolcraft	A. M. Fellows	" 20	170,000
	Schoolcraft	A. M. Fellows	" 20	170,000
Livingston	Hamburg	Geo. G. Winans	May 30	170,000
	South Lyons	W. W. Hendrick	June 13	102,000
	Brighton	J. A. Bigelow	" 13	102,000
	Brighton	T. T. Hynes	" 13	102,000
	Brighton	Charles Cushing	" 13	102,000
	Brighton	B. T. O. Clark	" 13	102,000
Lenawee	Hudson	J. B Welch	" 14	170,000
	Clayton	W. H. Littleton	" 14	136,000
	Adrian	Clark, Baker & Co.	" 14	170,000
	Adrian	S. Howell	" 14	170,000
Macomb	Romeo	Ed. T. Morton	May 29	272,000
Montcalm	Howard City	A. P. Thomas	June 13	102,000
	Greenville	C. C. Ellsworth	" 13	102,000
	Greenville	J. W. Belknap	" 13	102,000
Oakland	Pontiac	Geo. A. Nettleton	" 1	170,000
	Pontiac	J. E. Sawyer	" 4	170,000
	Orion	A. S. Warner	" 4	170,000
	Pontiac	Sylvester Cole	" 12	170,000
	Pontiac	H. M. Hurd	" 12	170,000
	Pontiac	C. A. Beardsley	" 12	170,000
	Melford	A. S. Wakely	" 18	170,000
	Highland	H. S. Holdridge	" 18	170,000
	Clyde	Allen E. Kenaga	" 18	340,000
St. Joseph	White Pigeon	J. R. Watson	" 14	170,000
	White Pigeon	V. R. Wilcox	" 14	170,000
	Klinger Lake	H. Weatherwax	" 14	340,000
Total				11,492,000

TABLE I.—*Distribution of Carp, 1887.*

County.	Name of Distributor.	Location.	Date of Shipment.	Number.
Allegan	J. W. Lindsley	Hopkins	August 26	25
	S. R. Atkins	Martin	September 17	25
	L. Conrad	Wayland	October 11	25
Berrien	S. Sheldon	Benton Harbor	September 20	25
	L. Kelley	" "	November 14	25
	F. Kelley	" "	" 14	25
Barry	A. Caldwell	Brouard	September 21	25
	G. W. Coppy	Hastings	" 19	25
Branch	A. W. Etheridge	Quincy	October 10	25
Calhoun	N. A. Osgood	Battle Creek	August 29	100
	S. G. Gossline	" "	October 19	25
Clinton	N. H. Silvers	Union Home	" 10	25
Charlevoix	J. A. Waggoner	Thumb Lake	" 4	25
Clare	J. Asline	Clare	" 7	25
Cass	N. Huff	Glenwood	September 12	25
	J. Brennan	Dailey	October 19	25
	N. Olmstead	"	" 19	25
	J. Withens	Jones	November 3	25
	B. Haight	"	" 3	25
	O. P. Bristol	"	" 3	25
	J. Draper	"	" 3	25
	Wm. Starr	Glenwood	" 3	25
Eaton	W. L. Freemire	Vermontville	October 31	25
Gratiot	M. S. Turck	Alma	" 10	25
Ionia	J. Betts	Pewamo	" 18	25
	A. W. Sherwood	"	" 31	25
	J. Wiles	New Haven Centre	" 31	25
Ingham	J. Daft	Lansing	November 4	25
Jackson	M. Meyers	Brooklyn	October 31	25
	C. W. Billinger	"	" 31	25
Kalamazoo	G. W. Chamberlain	Vicksburg	August 26	25
	A. A. Phillips	Kalamazoo	September 5	112
Kent	D. Osborn	Grand Rapids	August 29	25
	C. Snow	Lowell	September 19	25
	N. Helzel	Bockford	" 23	25
	J. E. Bradford	Sparta	October 3	25
	J. Court	Lowell	" 3	25
Lenawee	C. J. Pierce	Adrian	September 7	25
	P. Middleton	Thurber	" 7	25
Lapeer	G. W. Watson	Lapeer	" 20	25
Livingston	J. H. Bristol	Parshallville	" 15	25
Midland	C. C. Fouch	Coleman	August 26	25
Montcalm	N. Rykert	Howard City	September 21	25
	D. Dennison	" "	" 23	25
	O. R. Goodno	Carson City	" 23	25
	C. E. Collins	Cedar Lake	" 26	25
	S. Sage	Sheridan	October 3	25
	H. Henkel	Howard City	" 17	25
	J. Hatton	McBride	November 7	25
Newaygo	S. Butler	Grove	September 26	25
Osceola	M. A. Lapler	Hersey	" 20	25
	W. B. McDonald	Reed City	November 1	25
Ottawa	J. Sheffens	Holland	September 19	25
	C. O. Broden	Allendale	" 26	25
	F. Hedges	Lamont	" 26	25
	D. B. Porter	Eastmanville	October 4	25
	J. Balfour	Talmadge	" 4	25
	J. Phillips	Jamestown	November 7	25

TABLE I.—*Continued.*

County.	Name of Distributor.	Location.	Date of Shipment.	Number.
Oceana	W. R. Collins	Hart	September 20	25
	E. D. Richmond	"	October 3	25
	A. C. Stetson	Allen Creek	" 3	25
Oscoda	C. M. Cummings	Mio	" 10	25
Ogemaw	S. V. Thomas	West Branch	September 23	25
St. Joseph	H. A. Clapp	Sturgis	August 31	25
	Mrs. J. Vetterly	Three Rivers	September 7	25
	H. Fetteralf	" "	" 26	25
	G. S. Parker	Sturgis	" 29	25
	L. Theren	Three Rivers	October 10	25
	A. Chapman	Colon	" 11	25
	Mrs. M. Vetterly	Three Rivers	" 14	25
	J. J. Stanton	Burr Oak	" 14	25
	J. B. Dean	Colon	" 17	25
	F. Berlie	Three Rivers	" 21	25
Tuscola	M. H. Sorrel	Vassar	September 20	25
	J. R. Chapin	Easy	" 20	25
Van Buren	O. High	Hartford	July 29	25
	R. McConhay	"	" 29	25
	J. Rosefelt	Decatur	" 29	75
	C. A. Brigham	Lawrence	August 12	25
	L. S. Shaver	"	" 12	25
	E. Pardee	Sister Lakes	" 13	100
	J. Bridges	Bangor	" 26	25
	A. J. Loomis	Bloomingdale	" 29	25
	L. W. Vaughn	"	" 29	25
	T. Dorgan	Gobles	" 29	25
	T. B. Dougal	"	" 29	25
	G. Sloan	Decatur	" 30	25
	L. Long	"	" 30	25
	I. White	"	" 30	25
	F. W. Schoolcraft	Kendall	" 31	25
	G. Kendall	"	" 31	25
	R. Storey	"	September 5	25
	C. Vealey	Gobles	" 7	25
	G. Keller	"	" 7	25
	F. Kruglen	Bangor	October 31	25
Shiawassee	W. Colby	Shaftsburg	September 20	25
	W. R. Chappell	Corunna	" 21	25
	G. R. Bromdt	Byron	" 21	25
Washtenaw	P. Fleming	Dexter	" 21	25
Wexford	F. H. Bostwick	Thorp	" 26	25
	A. P. Johnson	Cadillac	October 4	25
Wayne	E. W. Voight	Detroit	September 23	25
	Isaac Marston	"	" 23	6
Total				2,843

TABLE J.—*Distribution of Carp for 1888.*

County.	Name of Distributor.	Location.	Date.	Number.
Allegan	J. F. Corning	Corning	July 16	30
	J. A. Newman	Glen	" 18	25
Alcona	W. C. Reynolds & Son	West Harrisville	August 20	30
Antrim	John M. Nelson	Mancelona	" 20	50
	Frank J. Lewis	Elk Rapids	July 18	25
Arenac	Lentz & Peterson	Arenac	" 16	30
	S. R. Hooper	Standish	September 20	30
	F. E. Cassellers	Sterling	October 27	30
Berrien	J. J. Aylsworth	Benton Harbor	July 13	30
	John Aylsworth	" "	" 13	30
	E. Nichol, Jr.	" "	August 8	50
	A. H. Wisner	" "	" 8	25
	E. Nickerson	" "	" 8	25
	John Ferry	Eau Claire	" 8	25
	Charles Vance	Steubensville	" 8	25
	W. H. Frank	Berrien Springs	September 8	40
	M. W. Lord	Glen Lord	" 24	50
Branch	G. G. Demott	Burlington	" 5	100
Calhoun	Edward Slighly	"	October 31	30
	H. B. Hall	Albion	September 3	30
Cass	Charles H. Kingsbury	Cassopolis	July 13	40
	John W. Bedford	Cushing	August 8	25
	W. Wells	Glenwood	September 24	50
	H. A. Snyder	Vandalia	" 28	30
	Worden Wells	Glenwood	October 1	50
	C. C. Merton	Dowagiac	" 21	75
	Asa Pray	"	" 26	60
Crawford	F. Thayer	Cheney	" 11	30
Cheboygan	E. Z. Perkins	Cheboygan	August 1	60
Clare	Thomas W. Brown	Farwell	October 23	30
Clinton	J. A. Valentine	Ovid	September 3	100
	Joseph Arens & Co.	Westphalia		27
Eaton	G. W. Sherwood	Charlotte	July 30	35
	E. & H. Boyd	Vermontville	August 13	25
	H. B. Shepard	Charlotte	September 10	30
Genesee	Albert E. French	Gaines	July 11	30
	George S. Woodhull	Fenton	" 11	30
	Homer L. Johnson	East Thetford	" 16	30
	W. W. Bartlett	Bartlett	September 5	210
Grand Traverse	J. L. Gibbs	Mayfield	" 5	30
Hillsdale	J. B. Patterson	Pittsfield	August 13	25
	W. H. Savage	Litchfield	" 6	25
Ionia	Erastus Hall	Saranac	July 16	30
	John P. Anderson	"	" 11	30
	A. W. Huntley	"	October 11	30
	H. J. Johnson	"	" 23	30
Ingham	H. N. Wixson	Mason	July 18	25
	Gottleib Leadley	Lansing	August 6	25
Iosco	J. C. Gram	Au Sable	October 11	30
Kalamazoo	J. T. Allerton	Galesburg	July 11	30
	Frederick Ott	Oshtemo	September 10	30
	Henry W. Moyer	Schoolcraft	August 15	30
Kent	C. S. Brown	Oakfield	July 19	25
	W. H. Culver	Grand Rapids	August 6	25
	Isaiah B. Sexton	Sparta	September 24	30
	D. Osborne	Grand Rapids	July 11	30
	Wm. Laughlin	Caledonia	October 16	30
	G. W. Thompson	Grand Rapids	" 16	30
Lake	James Armstrong	Forman	July 16	30

TABLE J.—*Continued.*

County.	Name of Distributor.	Location.	Date.	Number.
Lapeer	Geo. R. Lamb	Dryden	July 19	25
	M. N. Kelley	Metamora	August 20	30
	John H. Jones	Hunters' Creek	July 30	25
	Dennis Stocker	Metamora	October 31	30
	G. W. Stocker	"	August 20	30
Leelanaw	John A. Lawrence	Brigham	September 20	25
	Charles E. Egeler	Leland	" 24	50
Lenawee	Geo. W. Wingert	Thurber	August 1	30
Manistee	John Gordon	Onekama	July 18	25
	James Kuenzer	Pierport	September 24	30
	S. A. Viall	Manistee	August 6	25
	J. N. Hurlburt	"	" 1	30
Mecosta	Barton & Son	Big Rapids	" 13	25
	G. F. Langworthy	" "	October 21	30
Montcalm	J. W. Losee	Fenwick	September 20	50
	Henry Henkel	Howard City	October 11	30
	Wm. Rhodes	" "	" 23	30
	Fred Fahner	" "	" 23	30
Newaygo	Moses Malanson	White Cloud	" 23	30
Oceana	H. E. Waterman	Hesperia	August 13	25
	E. J. Shirtz	Shelby	July 18	25
	F. Utley	Hesperia	July 16	30
	W. H. Dunn	Shelby	August 1	30
Oakland	J. H. Holman	Rochester	July 18	25
	R. H. Glaspie	Oxford	" 18	25
Osceola	Wm. Mord	Dighton	August 13	25
Ottawa	James Balfour	Talmadge Center	September 20	30
	Otis Monroe	Lamont	August 13	25
	M. R. Merritt	West Olive	November 7	40
St. Joseph	Nathaniel Houston	Burr Oak	April 17	30
Shiawassee	C. T. Cook	Burton	August 20	30
Tuscola	Val. E. Boehmer	Brockway	July 19	25
	J. Baker	Jeddo	" 23	25
St. Clair	P. S. Barnum	Vassar	" 30	30
	Adam Harris	Mayville	September 10	30
Van Buren	G. B. Ridike	Lawton	July 24	25
	John Hudson	"	" 24	25
	C. H. Dalton	"	August 1	25
	C. F. Dey & T. F. Dodge	"	" 1	30
	O. P. Morton	Mattawan	September 24	30
	H. Coykendall	Williams' Crossing	October 9	30
	E. Pardee	Sister Lakes	" 23	300
	H. M. Overton	Bangor	April 17	30
Washtenaw	Emil Baur	Ann Arbor	July 9	30
	J. L. McCormick	Salem	" 16	30
	Ypsilanti Paper Co.	Ypsilanti	October 11	30
Wayne	Geo. W. Morgan	Detroit	December 4	16
Total				3,878

TABLE K.—*Total Plants of Brook Trout in Ten Years.*

1879	12,000	1885	408,000
1880	50,400	1886	719,000
1881	388,500	1887	1,060,000
1882	251,000	1888	1,639,000
1883	219,000		
1884	353,000	Total	5,129,900

The above is a statement of the plants of brook trout made from the Paris Station from and including 1879, the year in which the trout work of the Commission was removed from Pokagon to Paris.

TABLE L.—*Total Plants of Whitefish.*

1874	1,532,000	1883	23,735,000
1875	2,211,500	1884	37,750,000
1876	9,310,000	1885	40,000,000
1877	8,001,000	1886	61,620,000
1878	12,520,000	1887	72,984,000
1879	14,545,000	1888	72,968,000
1880	10,695,000		
1881	3,000,000		
1882	18,170,000	Total	389,041,500

PARIS STATION.

Temperature of water during the trout hatching season from October 4, 1886, to May 2, 1888.

1886.		1886.	
Oct. 4	51°	Dec. 18-20	40°
5-7	47	21-23	39
8-9	48	24	40
10-12	50	25-26	39
13	51	27-28	37
14-15	52	29-31	38
16	48	1887.	
17-18	46	Jan. 1	38
19	48	2	37
20	50	3-4	38
21	48	5	40
22	47	6	39
23	48	7	37
24	47	8-9	36
25	48	10	38
26	46	11	37
27	44	12	40
28	46	13-14	38
29-31	48	15	40
Nov. 1-3	48	16	41
4	47	17	39
5-6	46	18	35
7	44	19	37
8-9	43	20	40
10	45	21	39
11	43	22	40
12	42	23	37
13-15	43	24-25	39
16	42	26	35
17	44	27	38
18-21	42	28	41
22-23	43	29-30	38
24	41	31	36
25-27	42	Feb. 1	36
28-29	41	2	37
30	40	3	39
Dec. 1	39	4-5	37
2-6	40	6	39
7	41	7-8	40
8	40	9	36
9-10	42	10-12	38
11-12	44	13-14	37
13	42	15-16	40
14	41	17	41
15-17	39	18	40

PARIS STATION.—*Continued.*

1887.	
Feb. 19	39°
20	41
21-22	40
23	41
24-25	38
26	40
27	37
28	39
Mar. 1	38
2	40
3	39
4	38
5	36
6	39
7	41
8	39
9	42
10	40
11	42
12	41
13	40
14	36
15	37
16-20	38
21	40
22	38
23	37
24	39
25	37

1887.	
Mar. 26	36°
27	37
28	36
29-31	37
April 1	40
2	38
3	39
4-5	40
6	38
7	40
8-9	38
10	39
11-12	40
13	41
14-15	40
16	42
17-19	41
20	43
21	45
22	46
23	45
24	43
25	42
26	41
27	42
28	43
29-30	44
May 1	48
2	49

During trout hatching season from September 30, 1887, to May 31, 1888.

1887.	
Sept. 30	50°
Oct. 1-5	47
6-9	46
10-14	48
15-18	46
19-23	47
24-31	46
Nov. 1-4	47
5	46
6-9	44
10-16	43
17-25	44
26-30	43
Dec. 1-6	42
7-12	43
13-15	41
16-20	40
20-25	39
26-31	37
1888.	
Jan. 1-3	37
4-7	38
8-12	39
13-15	38
16	37
17-18	36
19	34
20	33
21	32
22	35
23	38
24	37
25-28	36
29-30	41
31	42
Feb. 1	43
2	41
3	43
4	42

1888.	
Feb. 5	40°
6	39
7	40
8	37
9	33
10	34
11	33
12	41
13-14	40
15	36
16-17	42
18	40
19	41
20	42
21	39
22	38
23	41
24-25	42
26	40
27-28	36
29	40
Mar. 1-2	40
3-4	38
5	37
6-8	36
9	40
10	42
11	40
12	38
13	36
14	37
15	40
16	42
17	38
18-19	42
20-21	38
22	36
23	35
24	36

PARIS STATION.—*Continued.*

1888.		1888.	
Feb. 25-28	40°	May 1	44°
29-31	38	2-4	46
April 1	40	5-7	48
2-4	39	8	44
5-7	38	9-10	46
8-9	42	11	48
10	40	12	50
11-12	38	13-14	44
13-14	40	15-17	46
15-16	42	18	45
17	40	19	44
18	42	20-22	46
19	43	23	50
20-23	44	24	52
24	45	25-26	48
25-26	44	27	43
27	46	28	47
28	48	29	49
29	46	30-31	52
30	44		

DETROIT STATION.

Temperature of water during the whitefish hatching season from Nov. 13, 1886, to April 15, 1887.

1886.		1886.	
Nov. 13-15	42°	Dec. 28-31	33°
16	41	1887.	
17	42	Jan. 1-31	33
18-19	41	Feb. 1-3	33
20-22	40	4-28	32
23-24	41	Mar. 1	32
25	40	2-31	33
26-27	39	Ap'l 1	33
28	38	2-3	34
29	37	4-7	35
30	36	8	37
Dec. 1-3	35	9-10	39
4	34	11	40
5-15	35	12-13	41
16-27	34	14-15	42

During whitefish hatching season from Nov. 16, 1887, to April 18, 1888.

1887.		1888.	
Nov. 16-18	43°	Jan. 8	33°
19	42	9-12	32
20-21	41	13	33
22-27	39	14-31	32
28	38	Feb. 1-22	32
29-30	37	23-24	33
Dec. 1-16	36	25-29	32
17-20	35	Mar. 1-8	32
21-29	33	9-11	33
30	32	12-30	32
31	33		
1888.		Ap'l 1-3	34
Jan. 1	33	4	36
2-5	32	5-7	38
6	33	8-17	39
7	32	18	40

PETOSKEY STATION.

Temperature of water during the whitefish hatching season, from Nov. 24, 1886, to April 4, 1887.

1886.		1887.	
Nov. 24-27	47°	Feb. 2-8	37°
28-30	46	9-11	36
Dec. 1-7	45	12-13	35
8-14	44	14-18	36
15-21	43	19	35
22-26	41	20	36
27-31	40	21-28	35
1887.			
Jan. 1-6	39	Mar. 1-6	36
7-15	38	7-15	35
16-24	37	16-22	36
25-31	36	23-31	37
Feb. 1	36	April 1-4	38

PETOSKEY STATION.—*Continued.*

During whitefish hatching season from Nov. 20, 1887, to March 25, 1888.

1887.		1888.	
Nov. 20-25	48°	Jan. 9-18	37°
26-30	47	19-22	35
Dec. 1-8	44	23-31	34
9-16	42	Feb. 1-3	34
17-21	41	4-8	35
22-28	40	9-29	34
29-31	39	Mar. 1-6	34
1888.		7-25	35
Jan. 1-8	39		

The catch of fish for 1886 actually reported to the Fish Commission by 180 firms, employing 625 men, was as follows:

	Pounds.
Whitefish	2,652,325
Trout	1,122,986
Herring	1,173,912
Bass	15,695
Sturgeon	440,978
Pickerel	514,624
Blackfins	34,000
Other kinds	201,623
Total pounds	6,156,143
Caviare	62,924
Total value at wholesale cost	$214,806.99
Total value at market price	492,491.44

The following nets were in use:

	No.
Pound nets	365
Gill nets	7,502
Seines	17
Fykes	54

The following boats were used:

Steamers	24
Sail boats	104
Pound boats	118
Skiffs	14

The catch of fish for 1887 actually returned to the Fish Commission by 146 firms, employing 555 men, was as follows:

	Pounds.
Whitefish	2,756,419
Trout	1,517,816
Herring	998,985
Bass	3,931
Sturgeon	299,843
Pickerel	447,943
Other kinds	238,142
Total pounds	6,263,079
Caviare	39,202
Total value at wholesale cost	$215,526.16
Total value at market price	501,046.32

The following nets were in use:

	No.
Pound nets	360
Gill nets	6,419
Seines	37
Fykes	21

The following boats were used:

Steamers	19
Sail boats	73
Pound boats	123
Skiffs	40

INVENTORY.

PARIS STATION.

118 acres of land, with overseer's house and meander of Cheney creek		$3,000 00
Superintendent's house	$1,400 00	
Barn	315 00	
Ice house	28 00	
Shop and office	100 00	
Old hatchery	600 00	
New hatchery	4,000 00	
Car house	200 00	
	$6,643 00	
Ponds, races, and other improvements to ponds	3,300 00	
		9,943 00
		$12,943 00
Pump logs	$260 00	
Apparatus and tools	690 00	
Two camp outfits	175 00	
		1,125 00
Total		$14,068 00
Car for transporting fish		3,550 00

DETROIT STATION.

Buildings, with frames and tanks	$6,710 00
Chase automatic glass jars	1,276 30
Fish cans	875 00
Tools, apparatus and furniture	636 37
Fishery at Fort Wayne	100 00
Total	$9,597 67

PETOSKEY STATION.

Building, water pipes and fixtures	$3,513 00
Residence	750 00
Four-inch main water supply	514 00
Total	$4,777 00

GLENWOOD STATION.

Winter house	$150 00
Cans	75 00
Tools, apparatus and fixtures	25 00
Total	$250 00

SECRETARY'S OFFICE.

Furniture	$110 00
Books and stationery	40 00
Library	30 00
Total	$180 00

RECAPITULATION.

Paris station	$14,068 00
Detroit station	9,597 67
Petoskey station	4,777 00
Glenwood station	250 00
Car for transporting fish	3,550 00
Secretary's office	180 00
Total	$32,422 67

INSURANCE.

PARIS STATION.

New hatchery	$2,500 00
Old hatchery	300 00
Superintendent's residence	600 00
Superintendent's barn	100 00
Overseer's residence	400 00
Trays, etc., in new hatchery	350 00
Trays, etc., in old hatchery	200 00
Camp outfit, etc	300 00
Wagons, harness, etc., in Superintendent's barn	50 00
Office and shop	200 00
Contents of office and shop	100 00
Car house	125 00
Total	$5,225 00

DETROIT STATION.

House	$3,000 00
Automatic jars	1,125 00
Total	$4,125 00

PETOSKEY STATION.

Hatchery	$1,200 00
Dwelling	300 00
Total	$1,500 00

Wm. A. Butler, Jr., Treasurer of the State Fish Commission, in settlement with Board of State Auditors, for year ending Sept. 30, 1887.

	Current Account, Quarter Ending Dec. 31, 1886.		
1886.			
Oct. 1.	Cash on hand	$396 18	
	From State Treasurer	3,000 00	
	From other sources	630 27	
	Disbursements as per vouchers		$4,729 57
	Quarter Ending March 31, 1887.		
1887.	From State Treasurer	3,000 00	
	Disbursements as per vouchers		2,899 83
	Quarter Ending June 30, 1887.		
	From State Treasurer	3,000 00	
	Disbursements as per vouchers		2,375 75
	Quarter Ending Sept. 30, 1887.		
	From State Treasurer	4,178 98	
	Disbursements as per vouchers		3,326 82
	Balance on hand		873 46
		$14,205 43	$14,205 43
	Special Account, Quarter Ending Dec. 31, 1886.		
1886.			
Oct. 1.	Balance on hand	$2 72	
	Disbursements as per vouchers		$2 72
	Quarter Ending Sept. 30, 1887.		
1887.			
July.	From State Treasurer	5,535 00	
	Disbursements as per vouchers		4,922 87
	Balance on hand		612 13
		$5,537 72	$5,537 72
	Special Account, Deficiency for 1886.		
1887.			
July.	From State Treasurer	$350 00	
	Disbursement as per voucher		$350 00
		$350 00	350 00

OFFICE OF BOARD OF STATE AUDITORS,
Lansing, November 30, 1887.

I hereby certify that the Board of State Auditors this day examined the within account current of the receipts and disbursements of William A. Butler, Jr., Treasurer of the Board of Fish Commissioners of the State of Michigan, for the year ending September 30, 1887, and find the same to agree with his vouchers on file in the office of the Auditor General, and find the balances on hand at that date to agree with the books of the Auditor General and have settled with said Treasurer on that basis.

G. R. OSMUN,
Chairman of the Board of State Auditors.

Wm. A. Butler, Jr., of Detroit, Michigan, Treasurer of the State Fish Commission, in Settlement with Board of State Auditors for Year ending Sept. 30, 1888.

	Current Expenses to Dec. 31, 1887.		
1887.			
Oct. 1.	Balance on hand		$873 46
	Cash from State Treasury		4,178 69
	Cash from other sources		411 72
	Vouchers	$5,484 95	
Dec. 31.	Balance overdrawn		21 08
		$5,484 95	$5,484 95
	Current Expenses to March 31, 1888.		
1888.			
Jan. 1.	Overdrawn	$21 08	
	Cash from State Treasury		$4,178 83
	Cash from other sources		47 51
	Vouchers	3,621 28	
March 31	Balance	583 98	
		$4,226 34	$4,226 34
	Current Expenses to June 30, 1888.		
1888.			
April 1.	Balance on hand		$583 98
	From State Treasury		4,179 44
	From other sources		20 07
	Vouchers	$4,148 15	
June 30.	Balance	635 34	
		$4,783 49	$4,783 49
	Current Expenses to Sept. 30, 1888.		
1888.			
July 1.	Balance on hand		$635 34
	From State Treasury		4,178 98
	Vouchers	$4,932 45	
Sept. 30.	Balance overdrawn		118 13
		$4,932 45	$4,932 45
	Special Expenses to Dec. 31, 1887.		
1887.			
Oct. 1.	Balance on hand		$612 13
	Vouchers	$575 89	
Dec. 31.	Balance on hand	36 24	
		$612 13	$612 13
	Special Expenses from Jan. 1, 1888.		
1888.			
Jan. 1.	Balance on hand		$36 24
	Vouchers	$36 24	
		$36 24	$36 24

OFFICE OF BOARD OF STATE AUDITORS,
Lansing, Dec. 26, 1888.

I hereby certify that the Board of State Auditors this day examined the above account current of receipts and disbursements of William A. Butler, Jr., Treasurer of the State Fish Commission, for the fiscal year ending Sept. 30, 1888, and find the same to correspond with the books of the Auditor General, and find the balance on hand at that date to agree with the books of the Auditor General, and have settled with said Treasurer on that basis.

G. R. OSMUN,
Chairman of the Board of State Auditors.

INSTRUCTIONS TO CHARLES H. BOLLMAN WITH MICHIGAN FISH COMMISSION'S CREW EXAMINING INLAND LAKES, SEASON OF 1888.

WASHINGTON, D.C., *July 5, 1888.*

Charles H. Bollman, Esq., care John H. Bissell, Esq., President Michigan Fish Commission, 33 Moffat Block, Detroit, Michigan:

DEAR SIR: Your duties in connection with the Michigan field party will be mainly those of a naturalist, to collect and preserve specimens of fishes and other aquatic animals, and make observations upon their distribution, abundance, habits, usefulness, etc.

The main object of your work will be to obtain a thorough and comprehensive knowledge of the aquatic fauna of the region, looking toward economic results.

The fishes are of greatest importance, and should receive most attention. You will not be able to carry a very large stock of alcohol with you in the field, and must therefore exercise due judgment in the selection of specimens to be preserved; always taking in preference the rarer species or those requiring comparison with types for their proper identification. It will be best, however, to make as large a collection as your means will permit. A careful record should be kept of all species not preserved.

Complete lists should be made of all the fishes found in each lake or stream; and as full notes as possible on the abundance of each species, its special habitat, its habits so far as they can be observed, its spawning season, size, and uses in the region where collected, either for food, for bait, or for other purposes, its common name, food, life history, etc.

The food of the more useful species should be ascertained by an examination of the stomach contents. As you will probably not be able to make this examination in the field, the stomachs, properly opened to permit the entrance of alcohol, should be preserved separately, either in bottles or in cloth bags placed in jars. Always save the stomachs with the contents, in order that their number may be known.

Relative to the life history, the most that you can expect to do will be to keep a diligent outlook for the young and eggs of all species, preserving a sufficient quantity of each in alcohol. Evidence respecting the time of spawning may also sometimes be obtained by examining the ovaries.

If any of the useful species have decreased in abundance, obtain as much evidence as possible respecting the amount of decrease, and its extent and causes.

Note all introduced species; ascertain the time of their original planting, if possible; observe whether they have become acclimatized and breed naturally.

Carefully examine the exterior surface, the gills, mouths and stomachs of fishes for parasites, which should be carefully preserved.

Preserve all specimens (or a fair number) of crayfishes and other crustaceans, mollusks, worms and other aquatic invertebrates which you collect. In fact it is my desire to obtain as much information as possible respecting the aquatic invertebrate fauna of the region you are about to visit—the names of the species, their abundance, distribution, their value to man in any way, and their relative importance as food for fishes. The dredge which has been forwarded to Mr. Bissell will enable you to obtain material from the bottom of the lakes. Crayfishes are sometimes taken in the seines. Some species live under stones. Mollusks often inhabit the shallow water near the shore. The dip-net should be used among the aquatic plants; and where such plants are abundant and the water sheltered, small organisms, such as Entomostraca and insect larvæ, generally swarm in great numbers.

Preserve all the invertebrates from each special locality in a separate bottle or vial.

If you hve sufficient botanical knowledge record the commoner aquatic plants in each lake, their relative abundance, and their distribution. It will also be well to note the general character of the land vegetation of the region; especially the prevailing trees, and their proximity to the water.

The amount of time at your disposal will necessarily influence the scope and minuteness of your inquiry, and I shall simply expect you to do the best you can.

Label all specimens very fully and carefully; giving date, locality, and all other necessary information; and make such additional memoranda in your note book as the occasion requires. Each bottle or lot of specimens should have a separate label plainly written with lead pencil. By using one series of numbers for your labels and note book, cross references can readily be made. Keep your notes well written up, and do not trust too long to memory. Suitable paper for labels will be sent you.

Trusting that you will have a pleasant and successful season, I remain,

Very respectfully,

(Signed) M. McDONALD,

Commissioner.

MICHIGAN FISH COMMISSION.

INSTRUCTIONS TO EXAMINING CREW.

SEASON OF 1888.

DETROIT, July 6, '88.

The superintendent will direct the crew where to begin operations in Kalamazoo county. The aim will be to finish that county and then come east in Calhoun county at the point most convenient for reaching the lakes to be examined there. If Calhoun county is finished before the superintendent calls the crew to go north, Jackson county will be visited. If the latter county is reached, it will be best to work in the same systematic way as formerly, so that if the whole county cannot be covered it will be completely done as far as the crew can go. For instance, it will be best to take the four northwestern or southwestern townships, or to finish up a chain of lakes.

The examinations this season are to be made in coöperation with the United States Fish Commission. To that end Mr. Charles H. Bollman will accompany the crew as the representative of the U. S. Fish Commission and as naturalist of the party. The officer in charge will see that Mr. Bollman is comfortably provided for at the camp, that his baggage is cared for and disposed of at his convenience, and that every facility is afforded him for the prosecution of his special work connected with the examinations. As a large part of the results of Mr. Bollman's work is for the benefit of this commission, we are interested in having it as complete and satisfactory as possible. Some of the ways in which assistance should be rendered him are as follows :

Whenever necessary see that he is provided with a boat, with one man to row if he requests it ; to take his direction as to times and ways of using drag ; to report to him every new form of life observed in or on the waters ; to procure for him, if possible, any species of fish or duplicates he may need ; under his direction to procure and furnish to him the stomachs of fish caught in the nets or by other apparatus.

Mr. Bollman will be expected to assist the crew in making up their regular report by identifying species if they are in doubt, by identifying varieties of food found in the stomachs of fish, and in making any observations on the characteristics of the waters or their fauna pertinent to the reports. It is hoped that as there is opportunity he may instruct the crew in matters connected with the examinations, and that he will make any suggestion that may tend to simplify, expedite or improve the work of the examining crew, or the result sought through their work.

So far as possible, the crew will examine the Kalamazoo river and spring brooks flowing it, looking for springs and spring-holes as indicating suitable water and places for brook-trout. The same for any large streams that can be reached from camp.

Get from all sources of information reports of brook-trout planted by the commission, taking names and addresses of informants, names and locations of streams referred to, and making notes of all points. In looking over streams inquire specially for indications of kinds and quantities of food.

JOHN H. BISSELL,
President.

LETTERS FROM FISHERMEN REGARDING WHITEFISH PLANTS.

FRANKFORT, MICH., *Aug. 15, 1888.*

Geo. D. Mussey, Secretary, Detroit:

In reply to yours of the 15th I will say, yes. I think the catch has increased, and planting is the only thing that will preserve the fishing interest of the great lakes.

Yours respectfully,

CHAS. BURMEISTER.

ALCONA, MICH., *Sept. 17, 1888.*

Geo. Mussey, Secretary, Detroit:

DEAR SIR:—In regard to the fish planting, I think it is doing a great deal of good. It is increasing the fish in the lakes. I have fished on grounds where fish have been planted and have caught them. I can tell you more after the fall fishing is over.

Yours respectfully,

JACKSON GREENMAN.

PENTWATER, MICH., *Aug. 22, 1888.*

Mich. Fish Commission, Detroit:

Speaking of whitefish, I would say they have been strangers around here for three years. I have seen some small ones this summer where we were fishing; I should think they would weigh from one-quarter to one-half pound. I think in planting, the fish should be put in the big lakes instead of the small ones, because the planted fish would have a better chance to get away from the perch and other small fish that eat them.

Yours,

ROBERT VERM.

No whitefish have been planted in small lakes for several years past.

COMMISSIONERS.

ST. JAMES, MICH., *Aug. 22, 1888.*

Geo. D. Mussey, Secretary:

DEAR SIR:—I received yours of the 15th inst. In regard to the fishing this year I would say the summer fishing is over, and has been very good with pound nets. The small mesh twine is done away with, and this gives the small fish a chance to get big. I have seen a class of whitefish that I never saw before. The ends of their fins are a little dark. I believe they are fish planted by your commission, and that the fishing will be better again.

Yours respectfully,

FRED BUTTS.

DETROIT, *August 22, 1888.*

Geo. D. Mussey, Esq., Secretary, City:

DEAR SIR:—Your circular of 15th inst., asking for information as to the success of planted whitefish, is at hand, and in reply would say that in the increased catch of the same, especially in Lake Erie, this present year, and the size of fish (being not of full

size), there is no reasonable doubt of their being planted fish. The increased catch in Detroit river last November also carries out the same theory, as they were much smaller and more soft and tender than the usual Detroit river whitefish. All of the fishermen and fish dealers with whom I have discussed this matter claim they are planted fish.

With suitable laws, properly enforced, to keep our lakes and rivers free from the refuse of sawmills, I believe it practicable to stock our waters again with the delicious whitefish.

Wishing you success, I am

Very respectfully yours,

JAS. CRAIG.

ISLAND HOUSE, TRAVERSE BAY, MICH.

Geo. D. Mussey, Secretary:

SIR:—In answer to your printed questions of August 15, I will say that I have fished right here, seven miles north of Traverse City, for the last eleven years. Of course there are not so many fish here now as there used to be; that is, not so many for me. I am a gill-net fisherman and always fish in deep water. Eleven years ago, so far as I know, there was not more than half a dozen pound nets in the bay, but five years ago the pound netters began to flock in here and have come more and more every year, and this fall there will probably not be far less than a hundred pound nets in the bay. You of course know they cover all the shoals and spawning grounds between this and the mouth or north end of the bay. I am now getting about half whitefish and half trout, but in a month from now, when the pound nets are all in, a whitefish will be a rare thing here. The law makes these pound nets 3½ inch mesh as manufactured; when seamed and tarred they are less than three inches and will hold very small fish. Now, inasmuch as you have asked me for my opinion of whitefish planting, I must say that in my opinion, if pound nets are not prevented from sweeping whole schools of spawning whitefish off their shoal spawning grounds, the amount of fish can never be kept up by planting or in any other way, for they will be swept clean every year. So far the law has been against gill nets and in favor of pound nets, for, so far as I know, a gill netter dare not set his nets on shoal spawning grounds, for if he does the chances are his nets will be chafed out and lost. Last fall I got more fish than any other fall since I have been here, but they were all black fins or long jaws and trout. After the pound nets got in I got no whitefish. I remember one morning I lifted 375 pounds and there was only nine pounds of whitefish among them. There are a great many more tons of whitefish caught in the bay now than there used to be, but the fish are small and get smaller every year here. It is my opinion the whitefish I get are planted fish, but those who planted them failed to put any ear marks on them, so I cannot tell for sure. In fact I don't see how they can help being planted fish, for it seems impossible for any fish to spawn on any spawning grounds in this bay without being caught in a pound net first.

I have a remedy for all this, but it is not likely I will ever be a law-maker, and we will continue to have our fish laws dealt out to us by men who are not practical fishermen and know less than nothing about the fishing business. I say plant fish, by all means plant fish; plant as hard as you can with both hands. It is a good thing, but for God's

sake give them five or ten minutes some time during the fall to spawn. I say stop everybody from fishing in twenty-five feet or less of water for ten or twenty days in spawning season and we will soon have whitefish again--plenty of them.

I think there has been salmon planted here. I caught one last summer that weighed six pounds.

Yours,

R. S. BASSETT.

ST. JAMES, MICH., *August 23, 1888.*

Geo. D. Mussey, Sec'y Michigan Fish Commission:

SIR:—I believe good results have followed the planting of whitefish. My own experience this season convinces me that the catch of whitefish has increased. We caught a different run of whitefish this season and believe them to be planted fish. We had a good catch.

WM. J. GALLAGHER.

HOLLAND, MICH., *August 27, 1888.*

Geo. D. Mussey, Sec'y:

DEAR SIR:—I have caught more whitefish this season than last. I have caught a large quantity which I am sure were fish planted by the commission. I will try and give you more information next season.

Yours respectfully,

GUS BAKER.

FRANKFORT, MICH., *August 23, 1888.*

Michigan Fish Commission:

In reply to yours of the 18th, I would say I will give, with pleasure, all the information I can in regard to the planting of fish. I have watched very carefully ever since the State undertook to propagate fish artificially, and am very glad to say that so far as my knowledge goes I have seen plenty of fish which had been planted by the State. I will give a few facts that have come to my knowledge during twelve years of my experience as a fisherman. In spawning time, as all know, the whitefish deposit their eggs on honeycomb rocks and generally very close to shore. I have known these to be deposited as close as in four feet of water. All these places swarm with perch and crawfish (crabs), which feed continually on these eggs from the time they are deposited until spring. What are not devoured are washed ashore in storms, and I have seen the beach covered with whitefish and trout spawn. Winter sets in and in these shallow places the water is frozen to the bottom and the eggs killed or carried away. In my opinion but one per cent or less are hatched.

My reasons for believing that artificial propagation is a success are these: First, there are places along the shore, away from spawning beds, where in years gone by no whitefish were caught with pound-nets, but where whitefish are now taken; second, of the fish caught not more than 10 per cent. contain spawn, which shows that they are young fish; third, of all the fish caught in pound-nets in the proximity of the spawn-

ing beds about 40 per cent. contain spawn, showing that many now reach full growth; fourth, in all localities a mile or more from shore a great many full-grown fish are caught, about 93 per cent. of which contain spawn, which shows that all the fish leave the shore as soon as they attain full growth, and do not swim along the shore after that.

Yours,

THOMAS RIEDECK.

ALCONA, MICH., *August 25, 1888.*

Geo. D. Mussey, Secretary:

DEAR SIR:—In regard to fishing, I would say that I have not fished for whitefish since 1886. That fall I caught eight or ten young whitefish that would weigh about one pound. I let them go in the lake again. I have fished since I was a small boy and never saw a young whitefish until they commenced planting them in the lake. I think it will be a big thing in the course of time.

Respectfully yours,

SAM. HILL.

FORESTER, MICH., *September 5, 1888.*

Geo. D. Mussey, Secretary:

DEAR SIR:—In reply to your letter of August 15, will say we are confident that the planting of whitefish is a success.

We notice more small fish than usual the present season. We got a good many fish that would average about 2½ pounds. In our opinion, these are some of the first planting.

Yours very respectfully,

ALLUE BROS.

CHEBOYGAN, MICH., *August 28, 1888.*

Geo. D. Mussey, Secretary:

DEAR SIR:—Yours of 15th received, in which you ask about whitefish. The catch has increased during the last two seasons in this vicinity, but I cannot say whether or not fish have been caught which were planted by the commission.

Yours truly,

ANDREW TROMBLEY.

MACKINAW CITY, MICH., *September 3, 1888.*

Geo. D. Mussey, Esq., Sec'y Mich. Fish Com., Detroit:

In reply to yours of Aug. 15 would say the present season has been a much better one than usual. The catch of whitefish has been more than double that of any year since 1880, and I am satisfied that it is caused by the planting of whitefish by the commission, which I believe is the only way to keep the supply good. Thanking you for your inquiries and your work, I am

Yours truly,

ALEX. DUFFINA.

ST. JAMES, MICH., *September 17, 1888.*

Geo. D. Mussey, Secretary Michigan Fish Commission:

SIR:—I have caught a large run of whitefish this season, and I do think they are some of the whitefish that were planted by the fish commission. I have good reasons to believe that it benefits the fishermen to plant fish.

Yours respectfully,

JAMES MOONEY.

Upon the receipt of the above letter, Mr. Mooney was written and asked to give some of the reasons for believing that the fish caught by him were planted. In reply the following letter was received:

ST. JAMES, *October 11, 1888.*

Michigan Fish Commission, Detroit:

Yours of September 20 is at hand. You make inquiries as to how I know that it benefits fishermen. Because one-third of the whitefish we caught this summer were Lake Erie fish; therefore I know they came from fry planted, as the Lake Erie fish are a stout, wide, small species of whitefish, with the tops of fins and tail black, while our natural Lake Michigan whitefish are long and slim, with one color of fins and tail. We never saw the Lake Erie fish here until we caught a few last season and great numbers this season in gill nets as well as whitefish nets.

Yours,

JAMES MOONEY.

In explanation of above reference to Lake Erie whitefish, it may be said that nearly all spawn taken by the commission since the beginning of artificial propagation has been taken from Lake Erie or Detroit river fish.

LETTERS FROM CITIZENS REGARDING BROOK TROUT PLANTS.

MT. PLEASANT, *August 13, 1888.*

Geo. D. Mussey, Sec'y:

DEAR SIR:—Your circular at hand and in reply would say that Mr. Geo. Granger has been at the head and front of trout planting in this county, and reports everything in first-class condition and every planting successful. The fishing is good and many avail themselves of the opportunity to engage in the sport of securing a most delicious fish for their tables. As near as I can ascertain the earliest planting was seven years ago in the town of Holland. This spring a brook trout weighing 3½ pounds was caught, so Mr. Granger tells me. The fish have multiplied very rapidly, and it is expected that an abundance of the gamy little fellows will supply the tables of our people in a very few years. We appreciate the good the fish commission of the State has done for us.

Yours,

A. S. CONTANT.

PAW PAW, MICH., *Aug. 13, 1888.*

Geo. D. Mussey, Esq., Secretary Mich. Fish Commission:

DEAR SIR:—Your circular of the 16th ult. at hand. In reply would say that the results that have followed the planting of brook trout in the streams of this locality have proven fairly satisfactory, and that the streams so planted bid fair to furnish a good supply of that choicest of all fish.

Our citizens are highly pleased with the work that has already been done. There is still an opportunity for still further profitable work in the same direction.

Yours, etc.,

O. W. ROWLAND,
Ed. True Northerner.

NEWAYGO, MICH., *Aug. 16, 1888.*

Geo. D. Mussey, Secretary, Detroit:

The results of planting brook trout in this vicinity have been highly satisfactory. They grow rapidly, some very fine ones being taken every season. Our people are greatly pleased with the system, and without an exception that I know of, are deeply interested in it.

Respectfully,

E. O. SHAW.

GALESBURG, *Sept. 10, 1888.*

Geo. D. Mussey, Secretary Michigan Fish Commission:

DEAR SIR:—Your letter of inquiry in relation to the planting of brook trout in the streams in this locality is of special interest to me as well as to my readers. In reply: 1. The results have been very gratifying, so much so, that trout fishing in season is now considered the rarest sport by all piscatorial artists. Two beautiful specimens have been caught in Camel's Creek, near here, 12 inches long, and worthy of the editorial notices they received throughout the country. 2. Our citizens universally commend it, and only regret that all available streams are not more fully stocked.

Respectfully yours,

E. E. THRESHER.

EVART, MICH., *September 11, 1888.*

Geo. D. Mussey, Esq., Detroit, Mich.:

DEAR SIR:—Yours of the 10th inst. at hand and contents noted. In reply would say that there is brook trout in every creek on northwest side of Muskegon river from Hersey to the Big Clam river. You will see by map that there is a number of smal streams that are not named, and there is trout in every one of them and have been caught. It seems that they run up and down Muskegon river and have for three years. This is the way that we account for them being in all the small streams. On the southeast side of Muskegon river they are very scarce. In some of the creeks they run up in the spring, but the water is not adapted for them, and as soon as it gets warm they leave and run out into the Muskegon river again. Some of the largest trout that have been caught here were caught in the Muskegon river. In your letter you have a Bull creek and a Kill creek. There is only one; it should be Bull Kill creek. This is on southeast side between Evart and Hersey. There are a few in that, but nothing compared with the streams on other side of Big river. Twin creek is the best fishing of any. If there is any further information that I can assist you in will only be too pleased to do so.

Respectfully yours,

J. C. CREITH.

LANSING, *September 14, 1888.*

Geo. D. Mussey, Secretary Michigan Fish Commission:

SIR:—In reply to your circular, I would say the work of the State Fish Commission of planting brook trout in Berrien county has been decidedly successful, as I know from personal observation. I have had good fishing and have taken many good-sized trout in streams stocked by the state, and know that your efforts in this direction meet with general approval among our people, especially as we find by experience that the reputation that there is good trout fishing in our vicinity attracts a class of visitors and summer tourists who spend money freely among us and add not a little to our business prosperity.

Yours truly,

J. H. HATCH, *of St. Joseph.*

SHARON, *October 29, 1888.*

W. D. Marks:

DEAR SIR:—I write to tell you that we had 5,000 brook trout put in our brook a year ago last March and 4,000 last March. We have caught some of them nine and one-half inches in length and weighing four ounces. There are smaller ones, of course, and there may be larger.

Yours respectfully,

F. J. WILLIAMS.

ALPENA, *October 7, 1888*

Geo. D. Mussey, Esq.:

DEAR SIR:—The 10,000 brook trout fry sent me have done splendidly. I caught seven this fall and put them back in the creek, except one, which weighed three-quarters of a pound and was thirteen inches long. The creek is full of young ones two and one-half to three inches long.

Yours,

HENRY BOTTORE.

BIG RAPIDS, *October 31, 1888.*

Geo. D. Mussey:

DEAR SIR:—Your circular was referred to me. I can say that every stream in this county is now filled with brook trout, and the scheme of planting them in the streams is generally regarded as a grand success.

Very respectfully,

W. F. SLAWSON,
City Editor Pioneer.

NOTICES FROM PAPERS IN REGARD TO BROOK TROUT PLANTS.

The Shelby *Independent,* of Oceana Co., of September 14, 1888, says:

"The history of the speckled trout in the brooks of this county is that may prove interesting to our readers at this time. The Oceana County Sportsmen's Society was organized in 1878, and 30,000 young trout planted in the streams of the county in February of that year. Two years later the plant was examined by the State Fish Commissioner, and pronounced a complete success. About 75,000 young trout were planted that spring. Since then there have been very few planted until the spring of the present year, when perhaps 20,000 to 25,000 were planted.

"Thus it will be seen that about 130,000 trout have been planted here, and they were protected by law in all seasons until May 1, 1884, since which time it has been lawful to catch them with hook and line in the months of May, June, July and August of each year. And the strings of speckled beauties that have been taken from the running waters of our county since then are numerous and fine. One specimen caught the present season weighed five pounds and one ounce, and dozens have been brought to this place weighing from three to four and three-quarter pounds each. Sportsmen from all over the state have visited our fishing grounds during the season just closed, and gone away convinced that there was something more substantial than talk about the fish stories of our citizens. Those who were most influential in securing the plant, placing young fish in the waters, watching their growth and protecting them from marauders while young, are, so far as we can recall their names, the following gentlemen: E. J. Shirts, Shelby; E. D. Richmond, A. S. White and L. G. Rutherford, Hart; D. C. Wickham, (George) and W. A. Rounds, Pentwater, and every one of these chaps knows how to fish for and catch the handsomest, most speckled trout that swim."

The Battle Creek *Moon* of August 3, 1888, says:

"Some years ago a fish commissioner was appointed for the purpose of stocking the streams of the state with choice varieties of fish. As long ago as 1881, trout were planted in brooks in this vicinity, and their growth has been a matter of watchful care on the part of the Sportsmen's Club, of this city. This morning, in speaking of the trout fishing in this locality with one of the club, we were told that they were thriving beyond the most sanguine expectations of the members. He related the fact that several large trout, weighing in the neighborhood of two pounds and a half, had been taken, and they were supposed to belong to the first plant made in this locality. The catch of one-half and pound trout has been large this season, no less than 300 having been known to be taken from the Pratt brook alone, while the catch in the Austin brook could not be estimated, as it appeared to be the fishing grounds of many of our local fishermen, on account of its nearness to the city.

"He said that nearly all the streams that presented the requisite condition for the growth of trout had been planted and that they all appeared to be thriving, and shortly the locality would be famous for its trout fishing. The State Fish Commission have been generous in their supply of small fry, every year large invoices being sent here, which were judiciously and carefully distributed and planted by the Sportsmen's Club, and before long the result would be noticeable. Our citizens generally appear to enjoy the sport which these gamy little beauties afford, and their appreciation of the endeavors of the commission is noticed in the conscientious manner in which they treat the plant, always throwing back those that were too small for the pan with as little injury to them as possible. On the whole, it is generally conceded that the labors of the commission in this locality have been a grand success, the details of which have been written up by competent members of the Sportsmen's Club and printed in the annual report of the commission. Battle Creek can now boast of as good fishing as many of the resorts, and people do not have to go miles away to enjoy a day with the rod and lines, thanks to the State Fish Commission.

The Whitehall *Forum* of August 16, 1888, says:

"We believe every sportsman, both local and transient, who has visited the brooks in this vicinity during the trout season this year has been amply repaid for his pains. The fish have attained a good growth and the brooks are prolific of them. Several trout weighing as high as three pounds have been killed here, and those weighing from a pound and a half to two pounds have been ordinary. The flesh is firm and savory and the brooks which thread the woods hereabouts appear to be perfectly adapted to the thrift of the speckled beauties."

The Ypsilantian of August 30, 1888, says:

"Mr. Walter Pack, who probably knows as much of the subject as any one here, assures us that the experiment in the streams south and west of this city has been very successful, and that those streams are well stocked with trout, but are not yet open because of successive plantings.

"A three pound trout, however, has been taken, showing the stream well adapted to the development of this dainty and fastidious species."

The West Branch *Times* of August 17, 1888, says:

"At least twenty spring brooks in this county have been planted with brook trout from the State hatchery during the past ten years. The experiment has proven very successful and the growth and increase of the fish has been most gratifying. Only a few of the streams nearest town can yet be fished, many of those farther away having been planted within the past two years. But trout fishing is now an attractive amusement for our lovers of sport, and in a few years Ogemaw county will be celebrated as a resort for seekers after these most delicious of the finny tribe."

The Jackson *Patriot* of August 22, 1888, says:

TROUT FISHING.

WHAT THE WATERS OF JACKSON COUNTY WILL SUPPLY IN THIS DIRECTION WITHIN A FEW YEARS.

"Upon inquiring yesterday of C. B. Bush, Levi French and others who assisted in planting the fry it was learned that quite a number of good sized trout have been captured in Crouch's creek, some weighing a pound and a half.

"Those conversed with on the subject appear to be very confident of the success of the undertaking, and believe that within a few years the waters of this vicinity will permit as good trout fishing as any in the State."

LIST OF FISH COMMISSIONERS.

THE UNITED STATES:
Col. Marshall McDonald, Commissioner, Washington, D. C.
Capt. J. W. Collins, Assistant in charge of Fisheries Division.
Richard Rathbun, Assistant in charge of Scientific Inquiry.
Col. John Gay, Inspector of Stations.

Alabama:
Col. D. R. Hundley, Madison.
Hon. Chas. S. G. Doster, Prattville.

Arizona:
J. J. Gosper, Prescott.
Richard Rule, Tombstone.
J. H. Taggart, Business Manager, Yuma.

Arkansas:
H. H. Rottaken, President, Little Rock.
W. B. Worthen, Secretary, Little Rock.
J. W. Calloway, Little Rock.
(This state has never made an appropriation for fish culture.)

DOMINION OF CANADA:
Hon. John Tilton, Deputy Minister of Fisheries, Ottawa.
(Inspectors of Fisheries for the Dominion of Canada, 1888: W. H. Rogers, Amherst, N. S.; A. C. Bertram, North Sydney, C. B. N. S.; W. H. Venning, St. John, N. B.; Wm. Wakeham, Gaspé Basin, P. Q.; J. H. Duvar, Alberton, P. E. I.; Thomas Mowat, New Westminster, B. C.: Alex McQueen, Winnipeg, Man.)
(Officers in charge of the Fish Breeding Establishments: S. Wilmot, Superintendent of Fishculture, Newcastle, Ont.; Chas. Wilmot, officer in charge, Newcastle hatchery, Ont.; Wm. Parker, Sandwich, Ont.; L. N. Cattellier, Tadoussac, Q.; Philip Vibert, Gaspé, Q.; A. H. Moore, Magog, Q.; Alex Mowat, Ristigouche, Matapedia, P. Q.; A. B. Wilmot, Bedford, N. S.; C. A. Farquharson, Sydney, N. S.; Isaac Sheasgreen, Miramichi, N. B.; Charles McCluskey, St. John River, Grand Falls, N. B.; Henry Clark, Dunk River, P. E. I.; Thos. Mowat, B. C. hatchery, New Westminster, B. C.)

California:
Joseph Routier, Sacramento.
J. D. Harvey, Los Angeles.
(Commissioner T. J. Sherwood resigned March 15, 1888.)
Colorado:
G. F. Whitehead, Denver.
Connecticut:
Dr. Wm. M. Hudson, Hartford.
Robert G. Pike, Middleton.
James A. Bill, Lyme.
(This state has no official superintendent, most of the hatching being done by Henry J. Fenton, Poquonnock.)
Delaware:
Charles Schubert, Odessa.
Georgia:
J. H. Henderson, Atlanta.
(Superintendent, Dr. H. H. Cary, La Grange.)
Illinois:
N. K. Fairbank, President, Chicago.
S. P. Bartlett, Quincy.
Geo. Breuning, Centralia.
Indiana:
Enos B. Reed, Indianapolis.
Iowa:
E. D. Carlton, Spirit Lake.
(Superintendent, Ole Bjorenson.)
Kansas:
S. Fee, Wamego.
Kentucky:
Wm. Griffith, President, Louisville.
P. H. Darby, Princeton.
John B. Walker, Madisonville.
Hon. C. J. Walton, Munfordville.
Hon. John A. Steele, Midway.
W. C. Price, Danville.
Hon. J. M. Chambers, Independence.
A. H. Goble, Catlettsburg.
J. H. Mallory, Bowling Green.
Maine:
E. M. Stillwell, Bangor.
Henry O. Stanley, Dixfield.
B. W. Counce, Thomaston, Sea and Shore Fisheries.
*Maryland:
Dr. E. W. Humphries, Salisbury.
G. W. Delawder, Oakland.
Massachusetts:
E. A. Brackett, Winchester.
F. W. Putnam, Cambridge.
E. H. Lathrop, Springfield.
Michigan:
John H. Bissell, Detroit.
Herschel Whitaker, Detroit.
Joel C. Parker, M. D., Grand Rapids.
(Superintendent, Walter D. Marks, Paris.)
(Secretary, Geo. D. Mussey, Detroit.)
(Treasurer, Wm. A. Butler, Jr., Detroit.)
Minnesota:
William Bird, Fairmount.
Niles Carpenter, Rushford.
Robt. Ormsby Sweeny, St. Paul.
(Superintendent, S. S. Watkins, Willow Brook, St. Paul.)
Missouri:
H. M. Garlichs, Chairman, St. Joseph.
J. L. Smith, Jefferson City.
H. C. West, St. Louis.
A. P. Campbell, Secretary, St. Joseph.
(Superintendents: Philip Kopplin, Jr., St. Louis; Elias Cottrill, St. Joseph.)

Nebraska:
Willim L. May, Fremont.
R. R. Livingston, Plattsmouth.
B. E. B. Kennedy, Omaha.
(Superintendent, M. E. O'Brien, South Bend.)
*Nevada:
W. M. Cary, Carson City.
New Hampshire:
George W. Riddle, Manchester.
Elliott B. Hodge, Plymouth.
John H. Kimball, Marlborough.
(Superintendent of Plymouth and Sunapee hatcheries, Com. E. B. Hodge.)
New Jersey:
William Wright, Newark.
Frank M. Ward, Newton.
J. R. Elkinton, Pennsgrove.
New York;
E. G. Blackford, President, New York.
Gen. R. U. Sherman, New Hartford.
Wm. H. Bowman, Rochester.
A. S. Joline, Tottenville.
Henry Burden, Troy.
(Secretary, E. P. Doyle, room 311, Potter Building, New York city.)
(Superintendents: Fred Mather, Cold Spring Harbor; Monroe A. Green, Caledonia, James H. Marks, Bloomingdale; E. L. Marks, Fulton Chain, and E. F. Boehm, Mill Creek.)
(Shellfish Commission: E. G. Blackford, Commissioner; William G. Ford, Engineer; J. W. Merserau, Oyster Protector, 80 Fulton Market, New York.)
North Carolina:
Wm. J. Griffin, Chairman, Elizabeth City.
J. B. Watson, Englehard.
Wm. T. Caho, Bayboro.
Ohio:
C. V. Osborn, President, Dayton.
A. C. Williams, Secretary, Chagrin Falls.
J. C. Hofer, Bellaire.
John H. Law, Cincinnati.
Hon. Emory D. Potter, Toledo.
(Superintendent, Henry Douglass, Sandusky.)
(Chief Warden, L. K. Buntain, Dayton.)
Oregon:
F. C. Reed, President, Clackamas.
E. P. Thompson, Portland.
R. E. Campbell, Renier.
(Terms expire in February, 1889.)
Pennsylvania:
Henry C. Ford, President, 524 Walnut street, Philadelphia.
James V. Long, Corresponding Secretary, 75 Fifth avenue, Pittsburgh.
H. C. Demuth, Secretary of Board, Lancaster.
S. B. Stillwell, Scranton.
A. S. Dickson, Meadville.
Treasurer, W. L. Powell, Harrisburg.
(Superintendents: John P. Creveling, Allentown; William Buller, Corry.)
Rhode Island:
John H. Barden, President, Rockland.
Henry T. Root, Treasurer, Providence.
Wm. P. Morton, Secretary, Johnston.
South Carolina:
Hon. A. P. Butler, Columbia.
*Tennessee:
W. W. McDowell, Memphis.
H. H. Sneed, Chattanooga.
Edward D. Hicks, Nashville.
Utah:
A. Milton Musser, Salt Lake City.

Vermont:
Herbert Brainard, St. Albans.
F. H. Atherton, Waterbury.
Virginia:
Dr. J. T. Wilkins, Bridgetown.
West Virginia:
C. S. White, President, Romney.
F. J. Baxter, Treasurer, Sutton.
James H. Miller, Secretary, Hinton.
Wisconsin:
The Governor, *ex-officio*.
Philo Dunning, President, Madison.
C. L. Valentine, Secretary and Treasurer, Janesville.
Mark Douglas, Melrose.
A. V. H. Carpenter, Milwaukee.
Calvert Spensley, Mineral Point.
E. S. Miner, Sturgeon Bay.
(Superintendent, Jas. Nevin, Madison.)
Wyoming Territory:
Louis Miller, Laramie.